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INTRODUCTION.

The annual publication on naval progress abroad should have gone to press in July, but due to the pressure of work resultant from the late war with Spain and the lack of a sufficient detail of officers until within the past two months, the preparation of this volume has been delayed, and advantage has been taken of this delay to bring its information up to the date of publication.

Richardson Clover,
Commander, U. S. N., Chief Intelligence Officer.

Navy Department, *November 24, 1899.*

Approved.
A. S. Crowninshield,
Chief of Bureau of Navigation.

I.

RECENT TENDENCIES OF FOREIGN NAVAL DEVELOPMENT AND THE EFFECT THEREON OF THE RECENT WAR WITH SPAIN.

By Lieut. Commander GEORGE H. PETERS, *United States Navy*,
Staff Intelligence Officer.

The purpose of this paper is to show the trend of foreign naval opinion and development, as represented in the professional press and other publications, on subjects of current interest. These foreign views and tendencies are given as being worthy of consideration, but not as being necessarily applicable to our own service.

INCREASE OF NAVAL STRENGTH.

In considering the principal foreign navies with a view of noting recent tendencies of development, the most striking feature which presents itself is the marked effort now making by the important maritime powers to increase their naval strength. Never before, except perhaps spasmodically during a naval war, has such endeavor been more vigorous or more general. Whether recognition of this be accorded willingly or unwillingly, it must be reckoned with. The importance of sea power is clearly perceived, and naval shipbuilding programs grow more extensive and more elaborate.

TYPES OF SHIPS.

In the apportionment of new tonnage abroad the large share set apart for battleships, notwithstanding their great cost, shows that responsible foreign opinion regards them as constituting the real fighting strength upon which reliance must be placed to win naval battles. This view was held long before the Spanish armored cruisers were destroyed at Santiago, but it now meets with general acceptance, and the assertion that the building of battleships is a wasteful use of money and resources is seldom heard. In France and in Italy, for special reasons, the armored cruiser is still held in relatively high esteem, and in the French press the claim has been persistently urged that the battleship will be deprived of its value by the submarine boat; but following this comes a recent request by the minister of marine for authority to lay down additional battleships for the French navy.

As battleships are intended to have the greatest possible fire energy, with the best protection attainable, their gun fire must be the maximum which their displacement will permit; and the latest foreign expert opinion is practically unanimous that their armor must not only protect the water line and the gun positions, but that the hull and the personnel must be effectively sheltered.

The typical features of the battleship, maximum offensive and defensive power, are not dependent on circumstances, but are ready at all times. Speed varies with conditions of service, and for battleships is regarded as a secondary consideration, although a very important one. The anxiety which the monitors caused Admiral Sampson has impressed anew upon foreign observers the need of strategic mobility. Other things being equal, the more efficient of two fleets of battleships will be the one whose slowest ship is faster than the slowest ship of the enemy. The aim abroad now is to have the battle fleet composed of ships having great offensive power and the best protection obtainable, with a minimum speed of not less than 15 knots. While some of the units may be capable of 18 knots, there should be none which can not be depended on for tactical evolutions at 15 knots speed. To attain this obsolete vessels must be replaced or modernized in accordance with the latest developments in engineering.

Next in importance to the battleship is the armored cruiser, which forms a prominent feature of the latest foreign shipbuilding programs. Vessels of this type have primarily high speed and great coal endurance; they are usually of large size and are given as much protection and as intense fire energy as practicable, but these qualities are secondary. While they may be used to supplement the fleet of battleships if necessary in maintaining command of the sea at strategic points, and are most useful adjuncts of such a fleet, it is held by many foreign writers that they have also a distinct field of operations. While these operations will not be decisive in their results in a war between great naval powers, yet the sudden opportune arrival of an armored cruiser, or of several of them at well-chosen points, may have a great influence on the war. Their size, speed, and armament enable them to engage successfully any except battleships. They are regarded as the most effective type for carrying on a cruiser war of depredation.

It was formerly held by some writers that armored cruisers would prove superior to battleships, owing to their greater speed, but since the close of the war with Spain such claims are seldom heard.

It is worthy of note, however, that with the effort to give increased speed to battleships and better protection to armored cruisers these two types tend to approximate.

Armored coast-defense vessels appear to be practically ignored in present foreign programs for the increase of modern fleets. There are two reasons for this, the first being the general belief that naval force will be mainly employed in sea contests rather than in merely defending home shores against attacks by an enemy. The second reason for not building new armored coast-defense vessels is that in the European navies it is felt that they already have a sufficient number of vessels of this type, and that future needs will be supplied by taking from the active armored fleet the older vessels as these are replaced from time to time by others of later type. In the British navy, in pursuance of this plan, the obsolete ships formerly stationed in home waters as coast-guard and port-guard ships have been succeeded by vessels which, though old, are still efficient. In Germany the same end is attained by the rule assigning a definite length of service—twenty-five years—to a battleship as such, upon the expiration of which she must be replaced by a new ship and transferred to the list of coast-defense ships. The monitor type is regarded abroad as having been thoroughly discredited by the experience of the war.

The need of making liberal provision for the building of cruisers is fully recognized abroad, and this has simply been emphasized by the recent war. Their essential qualities are speed, coal endurance, and means of coaling rapidly; with these characteristics their usefulness will be so great that no admiral will be likely to feel that he has enough of them. It is generally accepted that this is as true of cruisers to-day as it was of fast frigates in the days of Nelson. Whatever method of scouting or of search be adopted, the finding of a fleet at sea must always remain a very difficult problem, in view of the obstacles of limited horizon, unfavorable weather, fog, and darkness.

Very small cruisers and light-draught gunboats continue to be provided, their number and varying qualities depending upon the special needs of the different navies for cruising or for minor shoal-water operations.

With regard to torpedo boats and destroyers, foreign naval opinion is practically unanimous that the war has thrown no new light on the question of their value when used for the purposes for which they are intended. Navies which held them in high esteem before still continue to do so. Their vulnerability has long been recognized, as has the fact that they are peculiarly a weapon of opportunity, requiring for their successful use favorable conditions which may or may not be present at a given time and place. Their usefulness in the training of young officers is universally conceded. Organized as instructional flotillas or as a part of the mobile defense of ports, exercises with them are continuous and systematic and are not confined to the period of the annual manœuvres. Torpedo-boat destroyers, simply larger torpedo boats with increased gun armament and better sea-going qualities, are coming more and more into favor as the best type. In Germany it has been decided to build no more small torpedo boats. New ones are to be of the destroyer class, and will be as large as the former division boats.

Foreign torpedo officers believe that while torpedo boats are an accessory upon which dependence can not always be placed, yet their presence will have great moral effect, and that they are capable of very effective work. In foreign squadron manœuvres night attacks by torpedo boats have very frequently been judged to be successful, and it is urged that prior to the late war the number and tonnage of vessels sunk by torpedoes exceeded those destroyed by gun fire.

Submarine boats have not received much attention abroad of late, except in France, where a number of them of new type have been authorized.

While it has not yet received embodiment to any extent in new construction, foreign comment shows a clear apprehension of the need of a sufficient number of vessels for supply and auxiliary service, having the speed and other qualities requisite for efficiency. These are seen to include colliers fitted to give coal rapidly at sea, distilling ships to replenish fresh water for boilers, repair ships to obviate withdrawal for any except large repairs, ammunition vessels to make good the enormous expenditure of the rapid-fire guns, provision ships with refrigerating plants, telegraph cable steamers, fitted also for laying out submarine mines and for countermining operations, powerful tugs with mine-laying as well as wrecking facilities, and hospital ships.

ARMAMENT.

The view that a rapid-fire battery of moderate caliber, giving the greatest possible fire energy, should constitute the main reliance of battleships has been confirmed in the minds of foreign officers by the war with Spain. In the British navy the 6-inch rapid-fire gun continues in favor for this purpose. In all progressive navies rapid-firing guns are displacing those of older type. While a large allowance of guns of the smaller calibers is provided for special purposes, yet it is claimed by many experts abroad that in view of the abolition and removal of wood from ships, now in progress everywhere, these smaller guns will never again have the same relative importance that they had at Santiago, where it is noted that engines and boilers were not injured, steering gear was not damaged, and very few guns were dismounted. The unarmored portions of the sides of the Spanish ships simply served to explode the small projectiles, which killed and demoralized men and started uncontrollable fires. But better protection will hereafter be given, and rapid-fire guns of medium caliber will, it is claimed, become the crew-destroying weapon.

It is generally believed that future battleships will not carry any guns of larger caliber than the 12-inch, and by many foreign officers this is held to be excessive. It is claimed that such guns being accessory in their nature, their fire efficiency is not at all proportionate to the sacrifices which they require. An immediate effect of the war was to reduce the caliber of the heaviest guns of the new German battleships to 9.45 inches.

It is accepted that the armament of cruisers, whether armored or not, should be composed essentially if not entirely of rapid-fire guns.

Nearly all navies are endeavoring to accelerate their gun fire by improvements in mechanism and by the use of metal cartridge cases for all but the largest guns. The question of the best method of supplying ammunition, especially to meet the requirements of rapid-fire guns, is receiving earnest study abroad.

As an adjunct to the battery, various ingenious appliances, optic or electric, are in use abroad to communicate ranges and instructions to the guns. It is recognized that a hostile shell may paralyze this service, but the object will have been gained if superiority of gun fire can be achieved at the beginning of the battle.

Smokeless powder has long been considered abroad to be absolutely essential, and our recent experience has demonstrated the fact most fully. Such powder should be stable, practically without visible products of combustion, innoxious to the crew in action, and noninjurious to the bore of the gun, besides giving the requisite initial velocity. Foreign experience has shown that these qualities are difficult to obtain in satisfactory combination.

There is universal agreement abroad in the opinion that no provision should be made for the use of torpedoes by battleships and cruisers except in under-water tubes. On this point the experience of the naval battle of Santiago has only strengthened and made more general a view which has been gathering force for several years past, a view entirely independent of any consideration of the value of the torpedo in its proper sphere. Many progressive torpedo officers, as well as others, now hold that armament with this weapon should be restricted to torpedo boats, and good arguments are offered for its abolition from cruisers and battleships. But conservatism still keeps a few on board, and new designs for battleships in the desire for a maximum of offensive and defensive power retain submerged tubes. It is argued that recent improvements practically double the effective range of the torpedo.

ARMOR.

In no respect has there been a more marked crystallization of naval opinion abroad of late than that which has taken place on the question of the best distribution of the weight assigned to armor in a ship's design. All officers are now in accord that protection must be widely diffused, and that it can not be restricted to the water line and gun positions. The trend of professional opinion in the British navy has been in this direction for some time past, as is evidenced by the latest battleships and armored cruisers. Elsewhere there have been designs of date not much prior to the war with Spain which showed a very wide expanse of side without protection, while heavy armor guarded a few parts. A few years ago France produced, in the *Dupuy de Lôme*, an armored cruiser lacking in size, but having admirable general protection, but there has not been adherence to this feature. Some of the later foreign armored cruisers have no protection between the water-line belt and the gun positions on the main deck, but current discussion shows that in battleships and armored cruisers laid down hereafter this will not be repeated. The appalling disablement of crew which, under well-directed gun fire, may occur on board armored ships lacking widely distributed protection is now fully appreciated. The need of extending the armored water-line belt to the extremities is also urged, and the protection of the personnel in the conning tower is regarded as essential.

The recent war confirmed and impressed the lesson of that between China and Japan as to the absolute necessity of protection of the personnel. Proving-ground tests have shown for the latest new process face-hardened armor such a remarkable resistance to penetration that there can be much reduction of thickness, thus enabling the need for covering a more extended area to be met, although at increased cost. There has been a prompt acceptance of the new conditions.

In foreign armor contracts quality is made the feature of paramount importance, cost being a secondary consideration. The best type of armor procurable at the time is purchased. So general is this that it holds good not only in the more important foreign navies, but even in some whose expenditures are necessarily much restricted. The fact is fully realized that if a ship whose armor is contracted for to-day is hereafter to be tested in battle against an opponent having protection of a superior quality, permitting better distribution, this one point may have a decisive influence on the result.

SPECIAL FEATURES OF CONSTRUCTION AND EQUIPMENT.

The destruction of the Spanish ships by fire caused by American shells has led to universal effort to abolish wood and combustible materials from naval vessels. This effort is marked by such vigor that its results may practically be regarded as accomplished. In some of the latest ships the furniture is of metal or of fireproofed wood, the steel bulkheads have ornamental asbestos covering, and the steel decks are given a plastic nonflammable coating. Decks partly of wood are being replaced by steel. In clearing ship for action nothing combustible is permitted above the protective deck. Canvas boats permitting disassemblage and stowage below will be tested for some purposes.

The action of the French budget committee, in declining to make provision for the repair and maintenance of certain old wooden ships, recognizes the lack of military value of such vessels. A step in the same direction is the replacing of old wooden French ships for colonial service by others of more modern type. In these measures France is but following the policy already adopted in other navies.

Provision for extinguishing fire has been much extended and greatly increased. Fire mains are now carried under the protective deck, with numerous vertical leads from them.

The general adoption of water-tube boilers by progressive foreign navies has passed beyond the stage of discussion and may be regarded as an accomplished fact. The only point now remaining open in this respect is the question of the best type.

Search lights, rapid-fire guns of the secondary battery, flotillas of picket boats when at anchor, and numerous flanking torpedo-boat destroyers and cruisers when underway, form the chief defense of battleships against torpedoes. Recent improvements and attachments give torpedoes much greater range and accuracy than they have had heretofore and increase the need of defense against them. Thus the best position for search lights is one of great importance and has been much investigated abroad. The present practice is to mount some search lights aloft and others as low as they can be used in a seaway. The low ones, having their beams parallel to the water, are best for picking up an object on the surface, but their beams blind the gun pointers of the secondary battery. The lights which are placed high serve to illuminate the object after it is picked up. It is evident that cooperation between the search lights and the battery is necessary.

Though some foreign battleships still have torpedo nets, they are no longer regarded with favor abroad.

Military masts are considered important for battleships. The tendency is to shorten them, and their development is in the direction of armored towers with circular stairways, enabling men to go aloft to the fighting tops and to have ammunition supplied to them therein under protection. There is communication from the tops to the conning towers to facilitate reporting ranges and signals. For cruisers the present tendency seems to be to use pole masts.

The arguments against an extensive use of longitudinal bulkheads below the protective deck, which followed the capsizing of the *Victoria* after her collision with the *Camperdown*, have been counteracted this year by the fact that the German armored coast-defense ship *Aegir* was saved from sinking as a result of collision during fleet manœuvres by flooding compartments on the side opposite the injury, thus heeling the ship sufficiently to bring the leak above the water line. It is now held that valves to permit the passage of water across to opposite compartments will obviate the danger of capsizing.

Cellulose protection is still used. In some cases cork is preferred, in spite of its greater weight. Some authorities hold that to avoid any danger of corrosive action it is well to keep the cofferdams empty, clean, and dry, ready to be packed with cellulose in case of war.

PERSONNEL.

Efficiency of the personnel is universally recognized as of supreme importance.

In no direction does this manifest itself in a more marked degree than in the intense and continuous effort shown abroad to train gun pointers, with the object of having them attain the greatest possible practical efficiency. Prior to the war with Spain the published statements of results of foreign target practice gave some remarkable percentages of hits. Since the war, owing to greatly increased interest in the subject, still better results are said to have been achieved.

Not making sufficient allowance, perhaps, for battle conditions, foreign analysis of the effects of gun fire at Manila and at Santiago generally results in the assertion or points to the inference that the American gun pointers showed much room for improvement, both in the accuracy and in the rapidity of their fire, although they were vastly superior to the Spanish. In so far as these discussions are derogatory to the American gun pointers the comment is appropriate that never before have fleets been so utterly destroyed through gun fire.

In the British navy the allowance of ammunition for target practice and the amounts paid for prize firing have, it is stated in the press, been largely increased within the past year. The *Excellent* gunnery training establishment on Whale Island has been enlarged, and improvements are making to increase the facilities for target practice. The Sheerness gunnery school is reported in the press to be undergoing enlargement. English newspapers report negotiations in progress to secure land to permit the *Cambridge* gunnery school at Devonport to be established on shore, in accordance with the method followed at Whale Island. The same plan adopted there will probably be adhered to of having vessels to carry details to sea frequently for target practice underway under varying conditions of weather.

In the French navy the training of gun pointers has for some time past been a matter of special effort, and since the recent war these efforts have been redoubled. The exercises appear from press accounts to be of a very practical nature.

In the German navy prizes are offered for successful target firing to a greater extent than formerly, and nothing is left undone to stimulate interest in the practice. Press reports show that the vessels in commission at Kiel and Wilhelmshaven go to sea almost every day for target practice, which is not confined, as formerly, to their going out for manœuvres. Target practice is no longer confined to ships in commission, but also includes the vessels in reserve, which go out with reduced complements, in order to familiarize the personnel with the ships and to keep the vessels in serviceable condition.

Training is by no means confined to target practice, but goes on actively in every practicable way in all important foreign navies.

The tendency is very marked abroad to have men who are selected for special courses of instruction, as well as those awaiting distribution to the fleet, quartered in barracks ashore rather than on board of old hulks. It is found that better hygienic conditions can be obtained in barracks, and the results are more satisfactory in many ways.

Rapid coaling is now regarded as an essential requirement of the personnel and has received much attention, particularly in the British navy, where it is no longer regarded as mere drudgery, but has become an important evolution in which officers as well as men often take part, the greatest rivalry existing among the ships of a squadron.

Items which have appeared recently in English newspapers indicate that through thorough training of the fire-room force marked progress has been made in the extremely important matter of diminishing the amount of smoke discharged from the smoke-pipes.

The problem of securing an efficient naval reserve has long been a subject of serious study abroad, particularly in Great Britain, where the question assumes special importance, owing to the manning of the fleet being there dependent upon voluntary enlistment. The measure now in force in the British navy requiring new reserve men to serve on board ships in commission for a sufficient time to give them some idea of naval duties will, it is believed, have good results.

MOBILIZATION.

The importance of rapid mobilization is fully appreciated in foreign navies. Some of them, profiting by the experience gained in the annual tests in connection with naval manœuvres, have reached a high degree of proficiency in this respect, as is demonstrated by the facility with which officers and crews go on board strange ships to be temporarily commissioned, assume their duties at once, enter promptly upon the service to be performed, and upon its completion lay up their ships and turn in their stores without delay. The prompt mobilization last year upon short notice of a British reserve fleet, including well-drilled flotillas of torpedo-boat destroyers, in view of threatening foreign relations, afforded a notable example of the value of practice in such work.

NAVAL LEAGUES.

A movement in connection with naval matters which has received a remarkable impetus within the past few years in several maritime countries is the development of naval leagues—associations having for their chief aims the diffusion in popular form of information concerning the navy of the nation and advocacy of its maintenance and increase.

The league usually includes members of the imperial or royal family and comprises all classes of people. The dues are generally small. The amount of literature distributed throughout the country by the organization is very great, presenting in attractive shape, in periodicals, maps, and other publications, such information concerning the navy as is of general interest, with reasons for its maintenance, set forth in simple but convincing form. The effect is far-reaching. Even in those countries where the burden of large armaments is severely felt, any proposition offered in a legislative body looking to a reduction of naval expenses meets with determined opposition—an opposition prompted by the general desire of the people that the efficiency of their navy shall not be lessened. This affords a manifestation of the phenomenon which has excited comment within recent years, that coincident with the extension of democratic methods of government there has been evinced on the part of the people an increasing pride in their military and naval forces as representing in concrete form an expression of the strength of the nation.

II.

THE CREATION AND MAINTENANCE OF A GERMAN BATTLE FLEET.

Edited by Lieut. Sumner E. W. Kittelle, *United States Navy, Staff Intelligence Officer.*

There is a strong desire on the part of progressive Germans to build up a powerful navy to guard and to further the interests of German commerce and of German colonization abroad. It is proposed, if the consent of the Reichstag can be obtained, to add to the navy, over and above the present building program, which ends in 1904, 57 battleships, 15 large cruisers, and 36 small cruisers, the construction to extend over a period of seventeen years and to cost 1,700 million marks. It is believed that during this period the population and revenue of Germany will greatly increase, and that the burden assumed in carrying out this enormous naval increase will not be too heavy to bear. The plan includes a corresponding increase in the capacities of the navy-yards and a gradual increase in the personnel to man the ships as they are completed.

To educate conservative Germans in the need for a powerful navy, a pamphlet has been written by Mr. A. von Wenckstern and published in Berlin. In the introduction this work calls attention to the condition of affairs in the Pacific, and then proposes to elucidate three propositions: First, whether or not Germany needs ships; second, what types of ships; third, what resources has she to meet the expense of building.

Chapter 1 deals with the necessity for becoming a strong naval power, and sets forth the well-known, undeniable arguments for naval strength to preserve peace through the wholesome fear which such strength engenders in less powerful rivals.

Chapter 2 is on the necessity for a strong battle fleet to gain and hold command of the sea, and chapter 3 looks at the question from a naval, technical, and economical standpoint.

Chapter 4 sets forth the building project, and is so original that it will interest all who study naval policy. The translation is as follows:

> As yet only the general outlines of the economic basis upon which the creation of so strong a fleet is feasible have been indicated. Such a general conception is of course not sufficient for the practical requirements of the case. It is necessary to point out in detail that these are not Utopian dreams, but realizable facts. In no event is it the author's intention to recommend any precipitation. In no case does it seem necessary to hasten the completion of the fleet decided upon by the law of 1898.

War is by no means the object in view, but the creation of a strong fleet as the bulwark of peace. The projected fleet operates in our modern world, open to reason and reflection, with exactly the same moral pressure as would the completed fleet.

Thus it is to be assumed that the 1898 fleet is to be finished in 1903, and that from the year 1904 on about 50 million marks annually are to be made available for building new ships to replace old ones (Ersatzbauten), in order to maintain this "defensive" fleet at a strength of 19 battleships, 8 armored coast-defense vessels, 9 large cruisers, 26 small cruisers, and a reserve of 2 battleships, 3 large cruisers, 4 small cruisers, and the gun and torpedo boats provided for.

The maintenance of this fleet at that status, in view of the circumstance that it is intended to maintain a considerable portion of it in commission, will require an annual budget of 87.4 million marks. If about 12 million marks are added to this for the interest on the small loans to be taken and for pensions, a total annual budget of 150 million marks will be necessary for the maintenance of the fleet at the strength of the 1897 project.

For a battle fleet 6 squadrons are required. These 6 squadrons should be composed in the following manner: If, guided by the project of 1897, we deduct a portion of the large and small cruisers designated therein for the coast-defense division and for foreign service, a battle fleet of 17 battleships would be amply provided with 5 large and 12 small cruisers.

A double squadron would thus be composed of 17 battleships, to which 2 battleships could be appropriately added as reserve, hence 19 battleships and 5 large and 12 small cruisers.

Thus a total of 57 battleships, 15 large and 36 small cruisers would be required.

In order to keep the fleet at this status, the systematic renewal of the ships must be provided for from the outset in the same manner as required for the 1898 fleet, namely, by replacing a battleship at the end of twenty-five years, a large cruiser at the end of twenty years, and a small cruiser at the end of fifteen years.

For the keeping in commission of the battle fleet the same proportions may be adopted as formed the basis for the keeping in commission of the 1898 fleet, which, for the sake of brevity, is to be designated as the defensive fleet, while the fleet to be created may be called the offensive fleet.

The estimate for the personnel—that is, the cost of the personnel and of harbor works and barracks—should likewise be computed according to the principles of the 1898 law.

The question is, should larger and stronger ships be built in the future, so that the sums now set down—namely, 20 millon marks for a battleship, 15 million marks for a large cruiser, and 4.6 million marks for a small cruiser—would have to be increased?

This will hardly be necessary. Inasmuch as it is a question of the creation of a very numerous fleet, the building of very large individual ships can be dispensed with. On the contrary, the opinion which is being urged against the battle fleet generally, that it is altogether too great a risk to sink much larger sums than 20 million marks in one single ship, will come more and more to the front.

It would be correct to designate about 20 million marks as the maximum sum to be expended for one ship if there are a great number of such ships, and that with an increase in the price of material a slight decrease in the size of the ships might be made. The strength of the armament and of the armor, however, should in no case suffer.

It will suffice, on this hypothesis, to add 10 per cent to the figures already given. The cost of the double squadron would then amount to—

	Marks.
19 battleships, at 22 million marks	418, 000, 000
5 large cruisers, at 16.5 million marks	82, 500, 000
12 small cruisers, at 5.06 million marks	60, 720, 000
	561, 220, 000

Three double squadrons would cost 1,683,660,000 marks—in round numbers, 1,700 million marks.

The annual budget for such a fleet would be made up of the expenditures necessary in connection with the formation of the fleet, for harbor works and garrisons, for keeping ships in commission, and for the renewal of the fleet.

Upon the basis for the calculation for the 1898 law, it may be assumed that 75 per cent of the annual budget will be expended for the battle fleet of the 1898 law. Taking this number as a basis, the budget for the new offensive fleet would amount to 202.5 million marks annually (the budget for the 1898 fleet is 90 million marks, in round numbers, 75 per cent of which equals 67.5 million marks, which, taken three times, equals 202.5 million marks).

To this 10 million marks annually should be added for harbor works and garrisons, which brings the budget to 212.5 million marks. Finally, a sum of 76 million marks annually is to be provided for the renewal of the fleet, which is computed in the following manner:

	Million marks.
4 per cent of 418 million marks, battleships	16. 72
5 per cent of 82.5 million marks, large cruisers	4. 125
7 per cent (instead of 6⅔) of 60.72 million marks, small cruisers	4. 2504
	25. 0964

For 3 double squadrons the sum necessary for the renewal of the fleet will therefore amount to 76 million marks annually in round numbers.

Hence there will have to be provided the cost of the construction of the fleet during the first seventeen years, and an annual budget, increasing with the construction of the fleet, which will be made up of the sum necessary for keeping ships in commission, for the personnel, and for harbor works and garrisons, to which must be added from 1922 on the cost of the renewal of the fleet, gradually increasing to 76 million marks, at which figure it will remain.

The total costs therefore amount to 1,700 million marks for the construction of the fleet, an annual budget of 212.5 million marks after the completion of the fleet during the first seventeen years, and 377.5 million marks after the renewal of the fleet is in full operation and the liquidation of the building loans has been commenced.

During the interval preceding the completion of the fleet the budget will gradually increase to 212.5 million marks in the same way that it will gradually increase from 212.5 to 377.5 million marks after 1922, during which the building loans will have been paid by 1962, and will remain at 377.5 million marks after 1962 if the sum of 85 million marks, no longer needed for the payment of interest and the liquidation of the debt, will be kept available for new purposes of the fleet.

Hence the problem is to procure 1,700 million marks for the construction of the fleet, and for the fleet at its permanent status an annual budget of 377.5 million marks in addition to the 150 million marks which will be required for the defensive fleet.

Is Germany in a position to meet these demands?

In accordance with all the data given by statistics, which will be further confirmed by the results to be expected in the statistics of production during the next few years, the following prophecy as to the development of Germany in the immediate future can be made:

(1) The German population will increase in about the same manner as it has done during the last decade, in fact as it has done during the whole of the nineteenth century, namely, about 1 per cent per year.

This rate of increase has been considerably exceeded during the last few years. Even if the increase of the population at the rate of the last few years should be diminished, the assumption that the population will increase 1 per cent appears to be an absolutely certain fact.

(2) Hand in hand with the increase in population during the whole century there has been an increase in the income of the individual and in the total income of the people; not only in the sense that the income has increased in the same proportion as the population, so that therefore in spite of the great growth in population the quota per capita has remained undiminished, but in the sense that the quota per capita has also increased.

With the increase in population the income per capita has, in Saxony, for instance, been as follows during the years—

	Marks.
1882	345.53
1884	361.57
1886	385.67
1888	406.85

Prussia shows an equally constant tendency to increase. There the income per capita increased from 316 marks in 1876 to 329 marks in 1888 and 342 marks in 1890.

The most recent investigations further show that this movement did not come to a standstill in 1888. It is shown that in Saxony the income per capita amounted to 441.91 marks in 1892, against 327.41 marks in 1879.

The increase in population in Saxony from 1879 to 1892 was somewhat more than 1 per cent. That of the income per capita of this increasing population was in total about 34.97 per cent; that is, about 3 per cent annually.

English statistics are instructive in so far as they show the movement in population and income in a system of political economy developed to the utmost degree.

In England the taxable income, which was reached through the different ways by which a kind of income tax is raised in England, has increased from 11,704 million marks in 1881 to 13,804 million marks in 1895; that is, 18 per cent during the course of these sixteen years, or somewhat more than 1 per cent per year, with a simultaneous increase in population during the same period of from 34.9 to 39.1 millions, or only 12 per cent.

The increase in population in England is, therefore, somewhat less than in Germany; but there also it is shown that the increase in income per capita is somewhat greater than the increase in population.

From all this it follows that it is only a reasonable estimate of future development if it be assumed that hand in hand with the increase of 1 per cent in population there will also be an increase of 1 per cent in income. It is not even assumed that there is an increase in income per capita. On the contrary, it is only presupposed that it is not diminished per capita of population—a very moderate estimate in view of the German and English figures given above.

It can accordingly be assumed that, even without any increase in the demands upon the people in the way of taxes, the income of the States and of the Empire will increase about 1 per cent annually during the next ten years.

It is perhaps possible that as we advance in the twentieth century this increase may abate somewhat, or this may at least be assumed in order to proceed with absolute certainty, so that a fixed rate of increase in the annual income will be presupposed, which naturally amounts to about 1 per cent at first, but which will fall more and more below this figure the further we advance. Hence in this respect also there is taken into consideration an eventually slower increase in the distant future, which seems to be warranted only theoretically, but which in practice will very probably be replaced by a continuous increase at a regularly growing rate. At least this will be said by those who accept the development of the nineteenth century as a standard for that of the twentieth century.

If we take the year 1904, or 1905, as a starting point, it can be assumed that in accordance with the preceding suppositions the imperial revenue will increase about

16 million marks annually. That will be equal to about 1.06 per cent[1] for the first few years, 1 per cent for 1912, which will then steadily decrease to only 0.87 per cent in the year 1928.

Hence from the year 1905 on, it may be assumed that the scale of increase in the imperial revenue to be anticipated from the natural increase in population will be as follows:

1905	16	1911	112	1917	208	1923	304
1906	32	1912	128	1918	224	1924	320
1907	48	1913	144	1919	240	1925	336
1908	64	1914	160	1920	256	1926	352
1909	80	1915	176	1921	272	1927	368
1910	96	1916	192	1922	288	1928	384

This increase would cover the cost of the fleet, its renewal, the liquidation of the building loans and, from 1962 on, 85 million marks annually for new ships to be built in the future, or for greatly increased costs of construction, and this without tightening the taxation screw by even one penny, as compared with to-day.

It may seem doubtful whether the increase of 1 per cent in population and income will necessarily result in an increase of 1 per cent in the imperial revenue. It is possible that this increase will not take place in a purely automatic manner.

It is true that the failure of this increase is improbable. For, inasmuch as the imperial revenue is made up chiefly from the proceeds of customs and indirect taxes, it is exceedingly probable—yes, almost certain—that owing to the increased population and traffic, and to the increased commodities which will be demanded for the requirements of all grades of society, the imperial revenue will increase in a purely automatic manner parallel with the increase in the income of the people.

This seems to be indicated in particular by the development of recent years, which shows a regular increase in the imperial revenue not of 1 per cent, but of 3½ per cent, and that, too, without material changes in the system of imperial revenue having been the cause of this increase.

The regular revenues of the Empire were as follows in the years—

	Million marks.
1894	1,185
1895	1,229
1896	1,322
1897	1,268
1898	1,355

The year 1897 shows a decrease. Nevertheless, the regular increase of 3½ per cent can be established by changing the places of 1896 and 1897, so that 1,268 million marks will be given for 1896, and 1,322 million for 1897, whereby an increase of exactly 3½ per cent is shown.

In all probability this increase will continue until the year 1904, so that the imperial revenue will be as follows for the years—

	Million marks.
1899	1,410
1900	1,440
1901	1,470
1902	1,500
1903	1,530
1904	1,560
1905	1,590

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[1] On the supposition that the regular revenues amount to 1,481 million marks in the year 1904. In 1898 they amounted to 1,355 million marks. Hence a very moderate increase from 1898 to 1904 is anticipated, namely, only 1.5 per cent annually.

Consequently 16 million marks, as the annual increase, represents a very moderate estimate for the period from 1905 to 1950.

But even if we take a less rate and assume that henceforth there will be a natural increase of only 1.5 per cent (instead of 3.5), the regular imperial revenue would amount to 1,481.61 million marks in 1904, more than sufficient to cover the budget of the defensive fleet. If from 1905 on we assume an annual increase of 16 million marks in the regular revenue, this would represent an increase of 1.06 per cent for the year 1905, 1.057 per cent for 1906, and so on, to only 0.994 per cent for 1912, 0.92 per cent for 1920, and only 0.87 per cent for 1928, and so on; an increase which will take place without any question. The farther we advance the more the percentage falls below 1 per cent, so that the excess of the first years is more than compensated for. For the sake of brevity and a distinct characterization, this portion of the natural increase in the regular imperial revenue—this increase of 16 million marks a year, which the Secretary of State for the Navy will require to build and maintain an efficient fleet—will be designated as 1 per cent of the regular revenue.

If, contrary to expectation, as the years 1901–1904 will show, the increase in imperial revenue should not take place in this automatic manner, then, by means of a suitable policy in the apportionment to the separate States, the possibility is furnished of giving to the Empire a share of the growing returns of the revenue of the separate States.

An increase in population and income must necessarily be shown within the boundaries of the separate States. Probably the imperial revenue will increase as well as the revenue of the separate States. Provided now it can be shown by statistics that the population and income increase at the rate of 1 per cent, while the imperial revenue increases at only one-half or one-fourth per cent, the apportionment of the Empire to the separate States must be increased by as much more than 130 million marks as will be required to bring this one-half or one-fourth per cent up to 1 per cent. A legal precedent has been created by the law, according to which for the year 1896–97 the sum which the Empire has a right to retain from the customs and duties on tobacco, was increased from 130 to 180 million marks. The apportionments of the Empire to the separate States amounted to 441 million marks in 1898. They rose to this figure after 1894, in which year they amounted to 382 million marks. If we again change the places of 1896 and 1897, a regular increase will be shown here also, which may at least be taken as an index for the tendency, as follows:

1894	382.8
1895	400.1
1896	414.5
1897	404.05
1898	441.32

The Frankenstein clause might eventually be replaced by another regulation—the apportionment to the separate States would have to be fixed at 400 or 450 million marks. Everything in excess of this belongs to the Empire; and to the Secretary of State for the Navy belongs the natural annual increase of the regular revenue in so far as it exceeds that of the preceding year by 1 per cent—that is, in the first years, 1.06 per cent; later on, 1 per cent and less, so that 16 million marks will be added each year.

The construction of the fleet must be so organized, in accordance with the plan, that any rapid enlargement of the yards, etc., will be rendered unnecessary, and that after the fleet has arrived at a permanent status the yards will have abundant employment in the renewal of the fleet. After the full strength of the fleet has been attained the cost of the renewal of the defensive fleet will amount to 40 million marks annually; that of the offensive fleet to 76 or 80 million marks. Hence work to the amount of 130 million marks annually would be given to the yards.

If we bear in mind that from 1904 on 100 million marks annually are to be used for the construction of the offensive fleet, it will follow that during the years from 1904–1920 work to the amount of 50 million marks annually for the renewal of the defensive fleet and 100 million marks annually for the construction of the offensive fleet would fall to the share of the yards. From the year 1921 to the year 1925 this would diminish somewhat, because at first only a few ships would have to be built as renewal of the battle fleet. But from the year 1926 on the full renewal at 80 million marks would again set in, so that in keeping the fleets at a permanent status, the German yards would receive employment to the amount of 130 million marks annually.

In accordance with the plan, it is to be hoped that for this falling off of 20 million marks as compared with the increased activity in building from 1901 to 1920, the yards may be partially compensated by the fact that the merchant marine will make greater demands upon them, or that the works of the yards will have been fully utilized in the construction of the battle fleet.

In any event, it would be a question of small sums only which are risked the by yards, and the Empire would be in a position to offset this risk for the years of the standstill by means of a guaranty of interest, or—and this is the real proposition—it would have to be left to the execution of the details of the plan to further distribute the construction of the fleet over a few more years if necessary, so that the shrinkage for the years 1921–1925 will amount to nothing. The question here is merely to demonstrate that the economic possibility for the construction of the fleet exists at all.

An increase of 16 million marks in the imperial revenue is assumed. If we keep to these 16 million marks as a base, they justify the assumption of a loan of 100 million marks at 3½ per cent, and the expenditure of the aliquot part which falls to the share of 100 million marks in ships already built—that is to say, 12.5 million marks when the permanent annual budget amounts to 212.5 million marks.

It is shown how, with an annual construction to the amount of 100 million marks from the year 1904 on—namely, for the years 1905–1921, it is feasible to pay the interest on 100 million marks, gradually increasing to 1,700 million marks during the years 1905–1921, and to raise the budget to 212.5 million marks.

The loans of 1,700 million marks require an interest of 59.5 million marks, and the budget necessitates 212.5 million marks when it has become permanent. To this must be added 76 million marks annually from 1922 on, for the renewal of the fleet. In a table,[1] 16, 32, 48, and 64 million marks, respectively, are given for the period from 1922 to 1925, and then, in order to cover the difference of 144 million marks arising in consequence, 80 million marks instead of 76 are given up to 1961.

During the years 1922 et seq. the increase in imperial revenue rises to 288, 304, etc., up to 384 million marks for the year 1928.

These 384 million marks allow not only the entire payment of the total budget of 352 million marks, including the renewal of the fleet, but also the liquidation of the assumed debt to the amount of 25.5 million marks annually.

The further increase in the revenue after 1929 can be made available for other purposes. The debt would be paid by 1962. Consequently from 1963 on, 85 million marks annually would be available for new purposes of the navy.

Hence the question is twofold.

First, that the Secretary of State for the Navy lay claim to the natural increase in imperial revenue in so far as it amounts to 1 per cent of the regular income of the preceding year, in round numbers an increase of 16 million marks annually; and second, that this portion of the increase in imperial revenue be made productive in such a manner that by means of it annual loans of 100 million marks may be taken up, amounting in the course of seventeen years to a total loan of 1,700 million marks, which, beginning at the end of the first third of the century, can be liquidated in a lifetime, without a demand upon the natural increase in the imperial revenue of more than 1 per cent.

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[1] The table referred to is not given here.—O. N. I.

If the necessity for a strong offensive fleet is recognized, there will be no doubt at all that the Secretary of State for the Navy should not only by right, but as a duty, lay hands upon this 1 per cent of the imperial income.

It is the duty of the national parties (and the Center is one of them) to confirm this right and this duty of the Secretary of State for the Navy. If they should fail to recognize this duty they would commit the greatest political error; they would ignore their past history, a history which represents them as the parties which, each in its own way, have been the immutable power for the enforcement of the demands of the Government necessary for the safety of the Empire and for peace.

It is a question of security, of security not against continental but against naval powers. If the national parties together undertake the leadership of the enforcement of these requirements, they will gain the backbone to oppose with enormously increased strength the revolutionary parties in the interior of the Fatherland, using all necessary energy in quite a different manner from what has unfortunately heretofore been the case.

In regard to the assumption of the loan the following may be mentioned:

Germany annually converts into capital 3,000 million marks by investments, direct or indirect, in industrial activities. What will the sum of 100 million marks amount to against these 3,000 million marks when the former are converted into contractors' profits, wages, and interest on capital for all those who are employed in iron, coal, and food industries?

It is true that directly productive capital is not created through these 17 million marks which are required for the construction of the fleet, nor through the additional 80 million marks annually required for its maintenance. But there will be created by these expenditures the safe structure within which the other peaceful industries of the Empire can achieve great results. This expenditure, apparently contrary to political economy, is the indispensable prerequisite for the economic expenditure of the other 2,000.9 million marks which Germany's political economy converts into capital, of the certain income and of the increase of the 25 million marks national income, of the further development of German political economy, of German civilization, and of the German race.

Ought not Germany to be in a position to assume a loan of 1,700 million marks in the course of seventeen years without any disturbance of its political economy, especially when these 1,700 million marks will be paid back from the year 1928 on, in case it is so desired by the shareholders—when France from the year 1868 on, and hence especially after the war of 1870, was in a position to assume a loan of 9,000 million marks, although at the same time she already had another large debt of about 15,000 million marks—while to-day Germany has a debt of only 2,000 million marks, and the separate States, especially Prussia, have almost entirely covered their total indebtedness by state property?

France raised in the following years, respectively:

	Per cent.	Million francs.	Per ct. of income.
1868	3	450	69.25
1870	3	805	60.60
1871	5	2,000	82.50
1872	5	3,500	84.50
1881	3	1,000	83.25
1884	3	350	76.60
1886	3	900	79.80

> A total of 9,005 million marks in nineteen years, and of this 7,750 were raised after the war of 1870.
>
> I may refer back to the plan of Chapter III. Exactly as they were led ad absurdum who feared a retrogression in German economy in consequence of the increase of the army burden, and they were in the right who considered the increase of the military burden and an enormous growth in German economy entirely compatible, so will they also be in the right this time who say that this application of the imperial revenue for the purpose of the security of peace will result in a new growth in German economy, which will perhaps exceed the growth from 1816 to 1900 in a gigantic degree.

The fifth and last chapter is on the attitude of foreign countries, considering what view would be taken of such naval increase on the part of Germany. Continental powers are eliminated and the discussion narrowed down to Great Britain, Japan, and the United States, the ground being taken by the Militar Literatur Zeitung in a discussion of the pamphlet, that England and the United States will soon be checked in the increase of their navies by the question of manning the ships, and Japan by the question of money, so that Germany will be in a position to cope with them severally or collectively.

III.

NOTES ON SHIPS AND TORPEDO BOATS.

By Lieut. C. C. Marsh, United States Navy,
Staff Intelligence Officer.

1. BUILDING, ORDERED, AND PROPOSED.

CONSTRUCTION ABROAD.

England.—In the construction of the year abroad England has gone in for vessels of large size, both battleships and cruisers. The 27 latest English battleships are practically alike so far as constituting tactical units of a homogeneous fleet.

France.—France has laid down principally cruisers intended for commerce destroyers and a large number of submarine vessels, though no craft of the type has been carried through trials sufficient to demonstrate its success.

Russia.—Construction is divided in Russia between battleships and large cruisers, and the ice breaker *Ermack*, built in England on Russian designs, gives great prospect of keeping northern ports open during the winter.

Germany.—Germany's construction looks to work on the high seas, the vessels begun consisting of 4 first-class battleships and a new and large type of torpedo destroyer of great structural strength and seagoing qualities.

Italy.—Italy has apparently adopted Admiral Bettolo's design of an armored vessel of 8,000 tons.

Japan.—Japan is just completing her first building program, which provides for battleships of the largest size, for cruisers of 9,800 tons, and a very formidable torpedo flotilla.

ARMAMENTS AND ARMOR.

The noticeable feature is the similarity in the armaments of the battleships of the great powers, consisting essentially of four 12-inch guns in two turrets, and a number (10 to 16) of guns of about 6-inch caliber in the main battery. Italy alone is preparing to install the 8-inch gun.

The armor distribution is moving in the direction of a complete belt, which, as the quality of armor improves, is being reduced in thickness. The second feature is the tendency to spread the armor over the sides, forming a complete protection over the battery space. A comparison of the recent battleships shows that, excepting the French, this side armor, together with that on the casemates or small turrets, is 6 inches in thickness. It becomes, then, a question as to the superiority of the 6-inch gun or the 6-inch armor.

Recent experiments undoubtedly prove that at present the advantage is with the 6-inch armor. In experiments made at Indian Head in September of this year the 5-inch shell striking a 5-inch Krupp plate with a velocity of 2,068 feet penetrated but 2 inches with no cracks. This velocity of 2,068 feet is about the remaining velocity of 3,000 foot-seconds initial velocity at a range of 2,000 yards.

From experiments in England it appears that the latest 6-inch Krupp armor plates are barely perforable at a distance of 612 yards by the newest 6-inch Vickers gun. Hence, as the torpedo has a range of 800 yards, it may be assumed that the 6-inch Krupp armor plates will afford adequate protection against the 6-inch gun. These facts forcibly suggest the substitution for the 6-inch gun of a weapon capable of piercing armor at distances beyond the sphere of action of the torpedo.

ENGLAND.

The navy estimates for 1899–1900 amount to a net total of £26,594,500 ($129,422,134) as compared with the sum of £23,778,400 ($115,717,583) voted for the year 1898–99, showing an increase of £2,816,100 ($13,704,550.)

The total number of officers, seamen and boys, coastguard, and royal marines voted for the year 1898–99 was 106,390, being an increase on the previous year of 6,340.

A force of 110,640 is proposed for 1899–1900, being an increase of 4,250.

The additions proposed are to meet the larger requirements of the fleet, and are composed of—

Officers	463
Petty officers and seamen	1,700
Engine-room artificers and artisans	215
Stokers	1,000
Miscellaneous	172
Marines	500
Boys under training	200
Total	4,250

The following increases in the several lists of officers have been rendered necessary by the continued expansion of the fleet:

	From—	To—
Flag-officers	68	80
Captains	208	245
Commanders	304	360
Lieutenants	1,150	1,550

These additions will be effected gradually over a certain number of years.

The number of engineer officers is to be raised from 950 to 1,050, the increase to be spread over two years. Medical officers are to be raised from 450 to 490, gradually; chaplains from 59 to 69; chaplains and naval instructors from 50 to 60; naval instructors from 35 to 41; chief gunners and chief boatswains to be increased from 80 to 100; gunners and boatswains from 920 to 1,150; chief carpenters from 18 to 20; carpenters from 207 to 240.

Ships laid down in 1899.

Ship.	Class.	Tonnage.	Place.	Armament.
Venerable	Battleship, first-class.	15,000	Chatham	Four 12-inch, twelve 6 inch.
Bulwark	do	15,000	Devonport	Do.
Duncan	do	14,000	Thames	Do.
Cornwallis	do	14,000	do	Do.
Exmouth	do	14,000	Laird, Birkenhead	Do.
Russell	do	14,000	Palmer, Yarrow	Do.
Battleship No. 1	do	15,000	To follow Venerable	
Battleship No. 2	do	15,000	To follow Bulwark	
		116,000		
Drake	Armored cruiser, first-class.	14,100	Pembroke	Two 9.2-inch, sixteen 6-inch.
Euryalus	do	12,000	Vickers, Sons & Maxim	Two 9.2-inch, twelve 6-inch.
Bacchante	do	12,000	Clydebank, Glasgow	Do.
Leviathan	do	14,100	do	Two 9.2-inch, sixteen 6-inch.
Africa	do	14,100	Fairfield, Glasgow	Do.
King Alfred	do	14,100	Vickers, Sons & Maxim	Do.
Essex	do	9,800	Pembroke	Fourteen 6-inch.
Monmouth	do	9,800	Govan, Glasgow	Do.
Bedford	do	9,800	Fairfield, Glasgow	Do.
Kent	do	9,800	Portsmouth	Do.
Cruiser No. 1	Cruiser, third-class	2,000	do	
Cruiser No. 2	do	2,000	Chatham	
Cruiser No. 3	do	2,000	Devonport	
Espiegle[1]	Sloop	1,050	Sheerness	Six 4-inch, four 3-pounder.
Fantome[1]	do	1,050	do	Do.
		127,700		

[1] Improved Condor class.

Ships laid down in 1899—Continued.

Ship.	Class.	Tonnage.	Place.	Armament.
Racehorse	Torpedo-boat destroyers.	300 to 420	Newcastle-on-Tyne	
Roebuck	do		do	
Greyhound	do		do	
Lively	do		Laird, Birkenhead	
Sprightly	do		do	
Myrmidon	do		Palmer, Jarrow-on-Tyne	
Petrel	do		do	
Syren	do		do	
Success	do		Doxford & Sons, Sunderland.	
Falcon	do		Fairfield, Glasgow	
Ostrich	do		do	
Vixen	do		Vickers, Sons & Maxim	
		4,200		
		247,900		

Total number of vessels under construction or projected.

Class.	Number.	Tonnage.
Battleships	18	251,700
Armored cruisers	14	167,600
First-class cruisers	4	44,000
Second-class cruisers	4	22,600
Third-class cruisers	9	19,500
First-class gunboats	4	2,800
Sloops	8	5,880
Royal yacht	1	4,700
Torpedo-boat destroyers (350)	36	12,600
Torpedo boats (150)	2	300
Grand total of ships building, etc	100	531,680

FRANCE.

PROGRAM OF NEW CONSTRUCTION.

The French navy department on December 17, 1896, introduced into the program of new constructions for 1891 such modifications that the program has been completely remodeled and constitutes a new program altogether.

The ships to be put under construction in execution of the program of 1896, to the number of 240, are thus divided:

Class.	Number.	Tonnage.	Total.
			Tons.
Battleships	6	12,000	72,000
Armored cruisers	8	9,500	76,000
Do	3	7,500	22,500
Protected cruisers	8	4,000	32,000
Do	3	2,500	7,500
Dispatch vessels	3	1,300	3,900
Gunboats	4	650	2,620
Torpedo gunboats	10	400	4,000
Destroyers	25	305	7,625
Seagoing torpedo boats	58	150	8,700
Torpedo boats	112	80	8,960
Grand total of ships to be constructed	240	....	245,805

The appropriations required for the carrying out of this program are:

Fiscal year—	Francs.	United States equivalent.
1897	8,649,670	$1,669,986
1898	43,739,604	8,441,743
1899	71,512,928	13,801,995
1900	108,489,224	20,938,420
1901	119,697,720	23,101,639
1902	112,063,466	21,628,248
1903	107,621,417	20,770,933
1904	70,837,683	13,671,672
1905	26,813,952	5,175,092
1906	4,816,240	929,534

The following are the ships laid down in 1899. There is apparently considerable delay in France in laying down vessels provided for. Frequently one or more years elapse between the appropriation and the actual laying down of the keel.

Ships laid down in 1899.

Ship.	Class.	Tonnage.	Place.	Armament.
Suffren	Battleship, first class	12,728	Brest	Four 305 mm., ten 164.7 mm., eight 100 mm.
A8	do	12,728	do	Do.
Dupetit-Thouars	Armored cruiser (C3)	9,517	Toulon	Two 194 mm., eight 164.7 mm., four 100 mm.
Montcalm	Armored cruiser (C6)	9,517	do	Do.
Condé	Armored cruiser (C4)	10,014	Cherbourg	Two 194 mm., eight 164.7 mm., six 100 mm.
Gloire	Armored cruiser (C7)	10,014	L'Orient	Do.
Marseillaise	Armored cruiser (C9)	10,014	Brest	Do.
Sully	Armored cruiser (C8)	10,014	Toulon	Do.
Admiral Aube	Armored cruiser (C10)	10,014	Brest	Do.
Dupleix	Armored cruiser (D3)	7,700	Rochefort	Ten 164 mm.
Kléber	Armored cruiser (D5)	7,700	Bordeaux	Do.
(?)	Cruiser (H4)	4,000	Rochefort	Eight 100 mm.
(?)	Cruiser (H5)	4,000		Do.
Zélée	Gunboat (T2)	647	Rochefort	Two 100 mm., four 65 mm., four 37 mm.
Narval type (7)	Submarine boats	106		
223	Torpedo boat (P31)	84	Cherbourg	
224	Torpedo boat (P32)	84	Toulon	
225	Torpedo boat (P33)	84	do	
226	Torpedo boat (P34)	84	do	
242	Torpedo boat (P61)	86	Saigon	
244	Torpedo boat (P63)	86	do	
(?)	Torpedo-boat destroyer (M8)	311		
(?)	Torpedo-boat destroyer (M9)	311		
(?)	Torpedo-boat destroyer (N18)	181		
(?)	Torpedo-boat destroyer (N19)	181		
(?)	Torpedo-boat destroyer (N20)	181		
(?)	Torpedo-boat destroyer (N21)	181		
(?)	Torpedo boat (P64)	90		
(?)	Torpedo boat (P73)	90		
Pertuisane	Torpedo-boat destroyer	303	Rochefort	
Escopette	do	303	do	
Flamberge	do	303	do	
Rapière	do	303	do	
Sirène	Submarine boat, Narval type	106	Cherbourg	
Triton	do	106	do	
Bourrasque	Sea-going torpedo boat	150		
Rafale	do	150		
Borée	do	150		
Tramontane	do	150		
Français	Submarine boat, paid for by public subscription.			
Algérien	do			

SUMMARY OF TONNAGE LAID DOWN.

Battleships	25,456
Armored cruisers	92.151
Cruisers	8,000
Gunboats	647
Torpedo boats and destroyers	4,800
Total	131,054

The total amount demanded for the ministry of marine in 1899 is 304,078,400 francs ($58,558,527), or 17,121,454 francs ($3,175,837) more than for the year 1898. About half that increase is absorbed by expenditure on matériel. The other half is attributed, first, to additions to the number of vessels in commission; second, to the increase of the effective strength of the crews and marines, as also to the corresponding increase in the number of officers. In 1899 France will have no fewer than 91 war vessels on the stocks. The building of 63 of these vessels has already been commenced. The construction of the remaining 28 will be undertaken in 1899. The total of the amounts set aside for that purpose is 121,000,000 francs ($23,353,000) of which 96,000,000 francs ($18,528,000) is to go toward paying for the building of new vessels, whereas 17,000,000 francs ($3,281,000) is allowed for repairs and modifications of old ships, and 8,000,000 francs ($1,544,000) for plant and general expenses. The amount of the credit for the repair and modification of old vessels is large, but the French marine department considers it urgent to increase the fighting power of the ships built ten or fifteen years ago by changing and modifying the engines and boilers and the guns. The 63 vessels now being built consist of 4 ironclads, 11 armored cruisers, 4 cruisers, 8 torpedo destroyers, 2 submarine boats, 28 first-class torpedo boats, 6 small torpedo boats to be carried on board ironclads, 6 ocean-going torpedo boats, and 2 station gunboats. Thirty-eight of these vessels are to be completed and ready for service in 1899, viz, 1 ironclad, 1 armored cruiser, 3 cruisers, 8 torpedo destroyers, 1 submarine boat, 17 first-class torpedo boats, 6 small torpedo boats for ironclads, and 1 station gunboat. Twenty-eight new vessels are to be laid down in 1899.

Total under construction.

Class.	Number.	Tons.
Battleships	7	80,281
Cruisers	27	166,283
Torpedo vessels	72	8,969
Total	106	255,533

RUSSIA.

The total amount of the Russian navy estimates for 1900 is 87,564,700 rubles ($45,095,820), against 83,065,000 ($42,778,475) for 1899 and 67,050,000 ($34,530,750) for 1898. These amounts are divided under the headings "Ordinary" and "Supplementary," and these items for

1900 are 59,500,000 ($30,642,500) and 28,064,700 rubles ($14,453,320), respectively. Among the details are the following:

	1899.		1900.	
	Rubles.	United States equivalent.	Rubles.	United States equivalent.
Shipbuilding	34,062,537	$17,542,206	23,060,426	$11,876,119
Repairs of ships	....	....	6,266,886	3,227,446

The amount estimated for shipbuilding for 1898 was 19,316,976 rubles ($9,948,242).

Ships laid down in 1899.

	Tons.
Pobieda, battleship, first class, at Baltic Yard, St. Petersburg	12,500
Orel, battleship, first class, at Galerny Yard, St. Petersburg	13,600
Imperator Alexander III, battleship, first class, at Baltic, Yard, St. Petersburg	13,600
Borodino, battleship, first class, at Galerny Yard, St. Petersburg	13,600
Coast defense, at New Admiralty Yard, St. Petersburg	4,126
Protected cruiser, at Government Yard, Windau	6,375
Four torpedo-boat destroyers, at Schichau Yard, Elbing	1,400
Two torpedo boats, first-class	300
Total tonnage	65,501

Number of vessels under construction.

Class.	Number.	Tonnage.
Battleships	9	115,713
Armored cruiser	1	12,357
Cruisers	12	69,840
Torpedo-supply vessel	1	8,000
Mining transport	1	2,500
Torpedo-boat destroyers	42	14,066
Torpedo boats	16	2,500
Grand total	82	222,976

GERMANY.

By an order of April 10, 1898, it was decreed:

I.—The Necessary Ships.

(1) The ships necessary for the German navy will be, exclusive of torpedo vessels, school ships, special types, and gunboats, definitely fixed as follows:

(*a*) Available for service: 1 fleet flagship; 2 squadrons each of 8 battleships; 2 divisions each of 4 armored coast-defense ships; 6 large and 16 small cruisers as reconnoitering ships for the battle fleet in home waters; 3 large and 10 small cruisers for foreign service.

(*b*) The reserve material: 2 battleships, 3 large cruisers, 4 small cruisers.

(2) The following ships available and building on the 1st of April, 1898, are to be reckoned as part of what the navy shall consist: 12 battleships, 6 armored coast-defense vessels, 10 large cruisers, 23 small cruisers.

(3) The preparation of the material for reaching the requisite number of vessels will be done in accordance with the annual appropriations for new constructions, so that the legally prescribed number of vessels will be provided complete by the end of the fiscal year 1903.

The preparation of the means for the necessary substitute constructions will depend upon the annual allowances of the budget, in accordance with the following rule: Battleships and armored coast-defense ships must be replaced after twenty-five years, large cruisers after twenty years, small cruisers after fifteen years.

These periods run from the year in which the first installment of the displaced vessel is paid to the time of the payment for the first installment of the substitute vessel.

II.—The Requisite Personnel.

(4) Warrant officers, petty officers, and privates of the sailor division, dockyard division, and torpedo detachment shall be provided as follows:

1. For the vessels abroad, one and one-half complement for each.
2. Full complement for the following: For the active formation of the vessels belonging to the battle fleet at home; for one-half of the torpedo vessels; for school ships; and for special ships.
3. One-half of the full complement (with the exception of the engineers' force, of which there shall be two-thirds) shall be provided for the reserve formations of the vessels of the home squadron, and for the second half of the torpedo vessels.
4. The necessary land forces.
5. An addition of 5 per cent of the total.

INCREASE OF PERSONNEL.

The total of personnel of the navy has been increased from 24,906 in 1898 to 26,651 in 1899 (an increase of 1,745). Among this increase there are 48 officers, 10 naval doctors, 89 deck officers, 398 noncommissioned officers, 950 privates, and 250 ship boys; total, 1,745.

Ships laid down in 1899.

	Tons.
C, battleship, first class, Imperial Yard, Wilhelmshaven	11,081
D, battleship, first class, Schichau, Dantzig	11,081
E, battleship, first class, Germania Yard, Kiel	11,081
F, battleship, first class, Schichau, Elbing	11,081
C, small cruiser, Germania Yard, Kiel	2,800
Twelve torpedo-boat destroyers, Schichau, Elbing	4,200
Total	51,324

Number of vessels under construction.

Class	Number	Total tonnage
Battleships of 11,081 tons	9	99 729
Cruisers	10	41,851
Torpedo-boat destroyers of 350 tons	18	6,300
Torpedo-boat destroyer	1	355
Grand total	38	148,235

ITALY.

The naval estimates, ordinary and extraordinary, for 1899–1900 amount to 109,147,326 lire ($21,065,433), as against 105,325,124 lire ($20,327,748) for 1898–99, showing an increase of 3,822,202 lire ($737,684) over last year.

The Italian navy has recently decided on the construction of four armored vessels of 8,000 tons each. Bids have been asked for, and payment is to extend over a period of nine years.

Number of vessels under construction or completing.

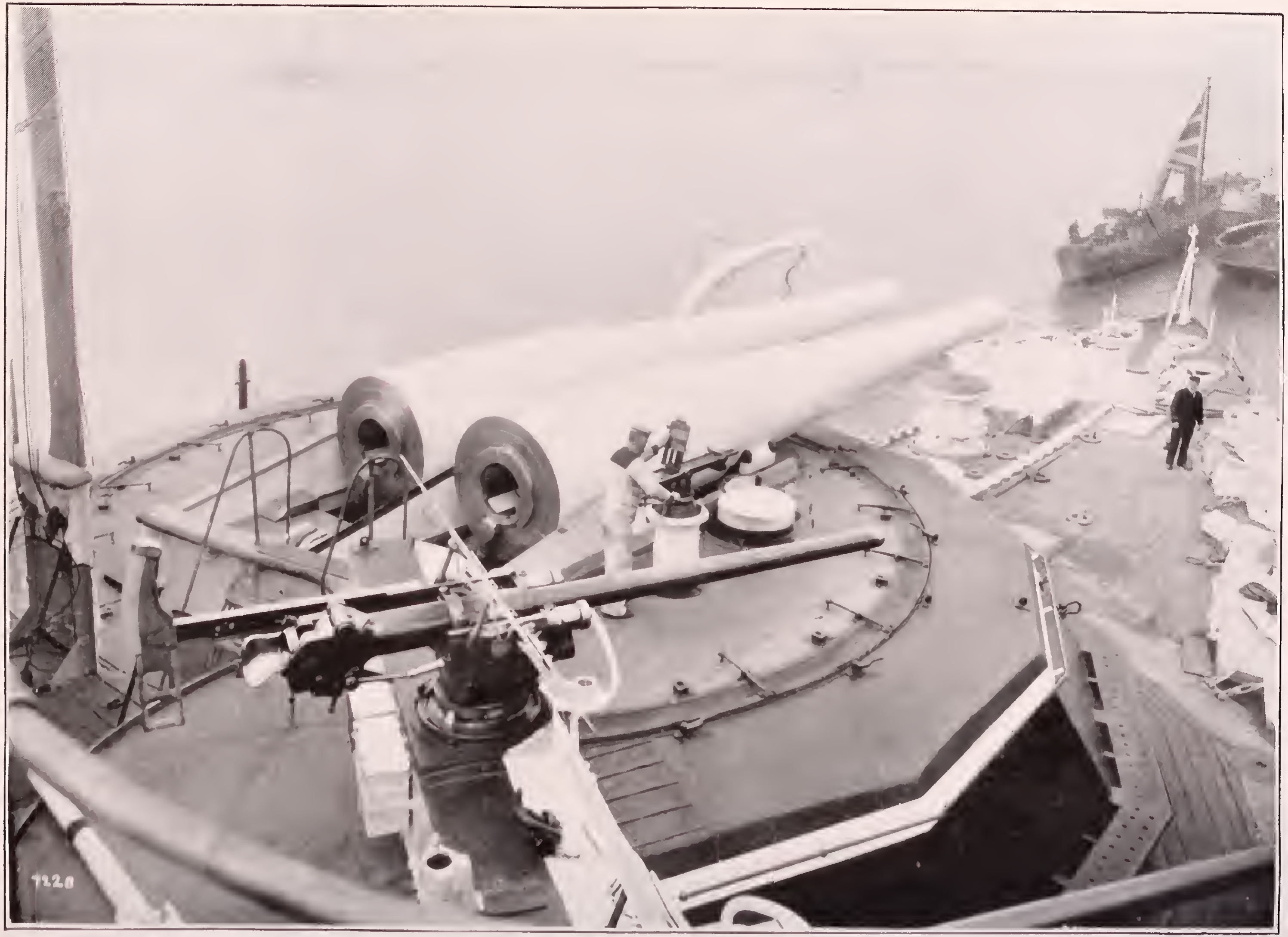
Class.	Number	Total tonnage
Battleships	4	46,454
Armored vessels, 8,000 tons (proposed)	4	32,000
Cruisers	7	38,901
Torpedo boats	11	3,185
Grand total	26	120,540

JAPAN.

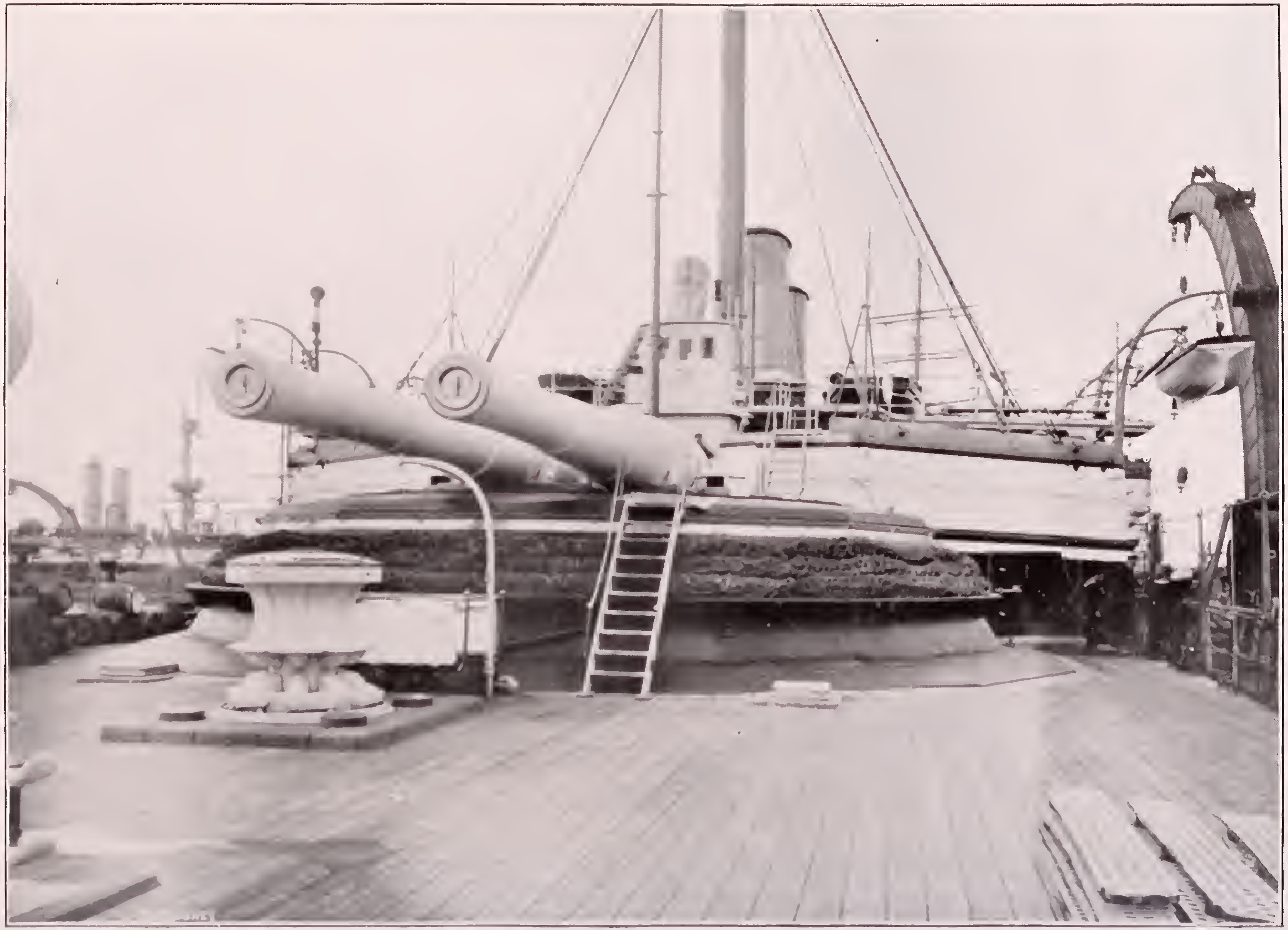
The naval program of 1895 makes Japan a sea power of the first rank. The program is to be completed by April 1, 1906. By 1901 there are to be 54 vessels in readiness; by 1906 65 more, or a total of 119 war ships. These are divided as follows: 4 battleships, 4 first-class armored cruisers, 3 second-class armored cruisers, 2 third-class armored cruisers, 15 torpedo cruisers, 89 torpedo boats.

On April 1, 1898, the Japanese navy consisted of 3 battleships, 10 second-class armored cruisers, 8 third-class armored cruisers (3 of antiquated type), 9 fourth-class armored cruisers (all of antiquated type), 15 old gunboats, 3 dispatch boats, 8 training ships, 9 transports.

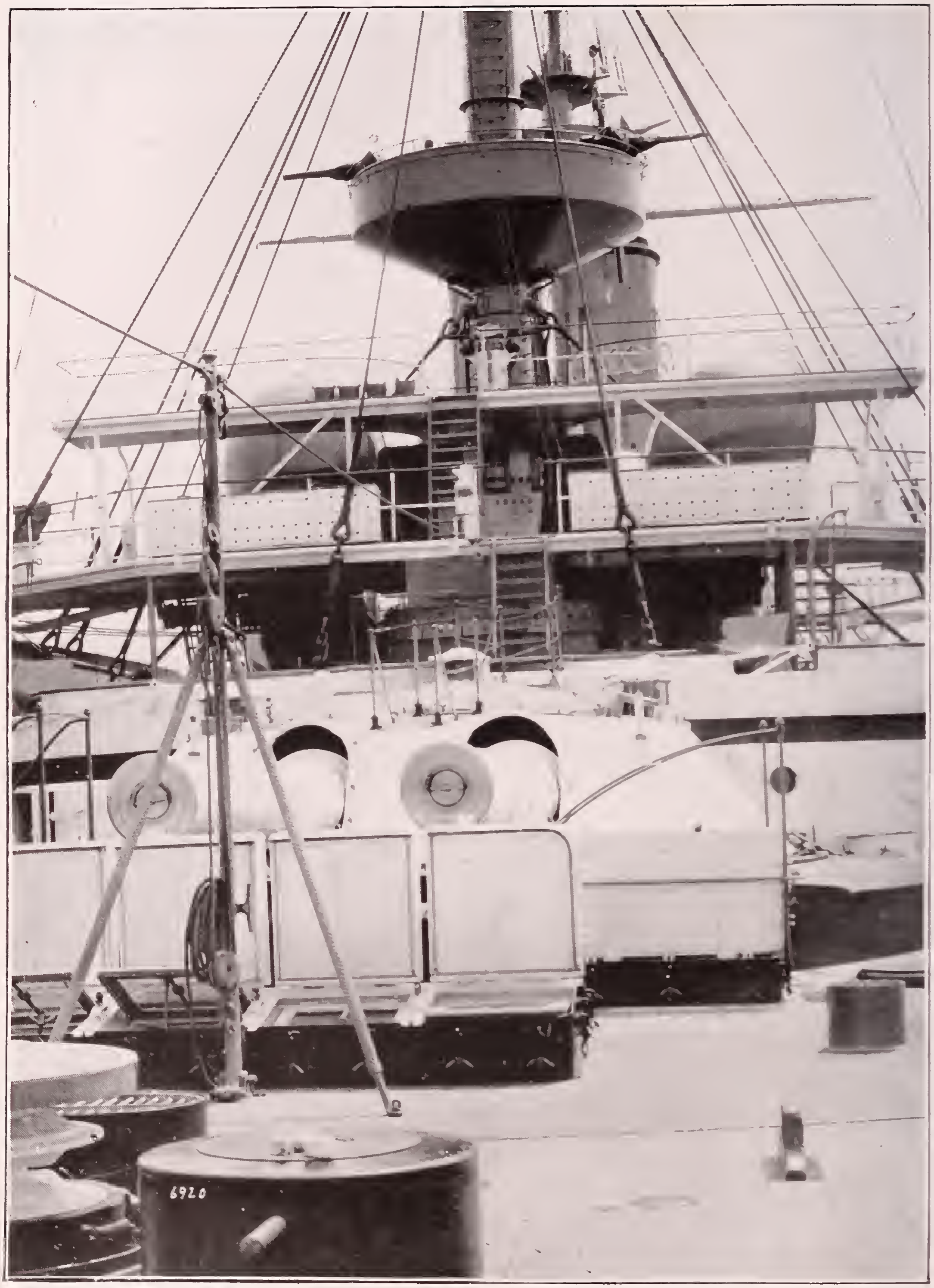
The following are now under construction in Japanese, French, United States, English, and German ship-yards: 4 battleships of the largest type, 9 armored cruisers of different classes, 3 torpedo cruisers, 12 torpedo-boat destroyers, 23 seagoing torpedo boats, 66 second and third class torpedo boats, 2 hospital ships.



RODNEY. (British battle ship.) Forecastle, showing barbette and heavy guns, without hood.



RODNEY. (British battle ship.) Quarter-deck.



MARS (British battle ship.) Quarter-deck.

This enumeration shows that all the new vessels provided for under the naval program are either completed or in process of construction.

It is reported that Japan has ordered 1 cruiser, third class; 2 torpedo gunboats; 1 reserve torpedo boat; 11 torpedo boats, first class; 16 smaller torpedo boats.

Number of vessels under construction.

Class.	Number.	Total tonnage.
Battleships of 14,850 tons	2	29,700
Battleships of 15,000 tons	2	30,000
Cruisers	9	63,280
Torpedo-boat destroyers	12	3,540
Torpedo boats	40	3,593
Grand total	65	130,113

ENGLAND.

Battleships, First Class.

DUNCAN, CORNWALLIS, EXMOUTH, AND RUSSELL.

	Built at—	Begun.
Duncan	Blackwall	Nov., 1899
Cornwallis	do	
Exmouth	Birkenhead	
Russell	Jarrow	

Dimensions.—Length, 405 feet; beam, 75 feet 6 inches; draught, mean load, 26 feet 6 inches; displacement, 14,000 tons; weight of hull, including armor and backing, 9,055 tons.

I. H. P., 18,000. Speed, estimated, 19 knots, natural draft, eight hours' trial; 18 knots, continuous steaming. Coal capacity at load draught, 900 tons; full bunkers, 2,000 tons.

Cost, when equipped for sea, £1,150,000.

Armament.—Four 12-inch B. L. (50-ton) wire guns, in two barbettes with 11-inch armor; twelve 6-inch B. L. R. F. guns, in casemates with 6-inch armor; twelve 12-pounder guns; twelve 3-pounder guns; four machine guns; four submerged torpedo tubes.

Protection.—Armor: Belt, 7 to 4 inches thick, extending to bow; bulkhead, 11 to 10 inches; barbettes, 11 inches; casemates, 6 inches; deck.

Motive power.—Boilers, 24 of Belleville type. Weight of machinery, 1,580 tons. Working pressure, 300 to 250 pounds.

CRUISERS, FIRST CLASS (PROTECTED).

SPARTIATE, AMPHITRITE, ARGONAUT, ARIADNE, ANDROMEDA, DIADEM, EUROPA, AND NIOBE.

SHEATHED AND COPPERED.

(Page 35, No. XIV; page 51, No. XV; page 32, No. XVI, Part II; page 175, No. XVI, Part IV.)

	Built at—	Begun.	Launched.	Commissioned.
Spartiate	Pembroke	May 10, 1897	Oct. 27, 1898	....
Amphitrite	Barrow	Dec. 8, 1896	July 5, 1898	....
Argonaut	Govan	Nov. 23, 1896	Jan. 24, 1898	....
Ariadne	Clydebank	Oct. 29, 1896	Apr. 22, 1898	....
Andromeda	Pembroke	Dec. 2, 1895	Apr. 30, 1897	....
Diadem	Govan	Jan. 23, 1896	Oct. 21, 1896	July 19, 1898
Europa	Clydebank	Jan. 10, 1896	Mar. 20, 1897	Nov. 23, 1899
Niobe	Barrow	Dec. 16, 1895	Feb. 20, 1897	Dec. 6, 1898

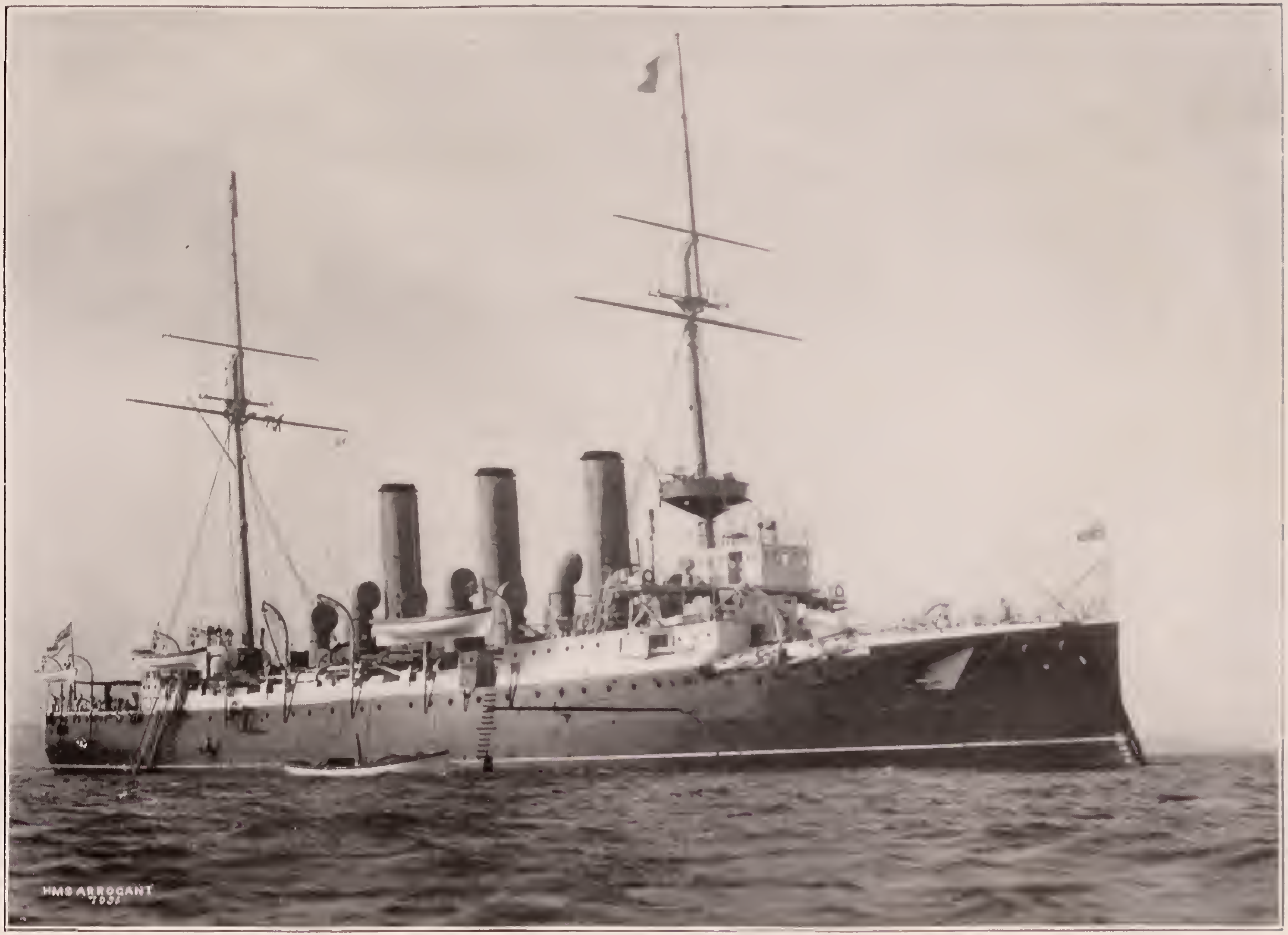
Dimensions.—Length between perpendiculars, 435 feet; over all, 462 feet 6 inches; beam, 69 feet; draught, mean load, 25 feet 3 inches; displacement at load draught, 11,000 tons.

Armament.—Sixteen 6-inch R. F., twelve 12-pounder R. F., two 12-pounder boat or field R. F., three 3-pounder R. F., eight .45-inch Maxim machine; torpedo tubes, two submerged and one above water.

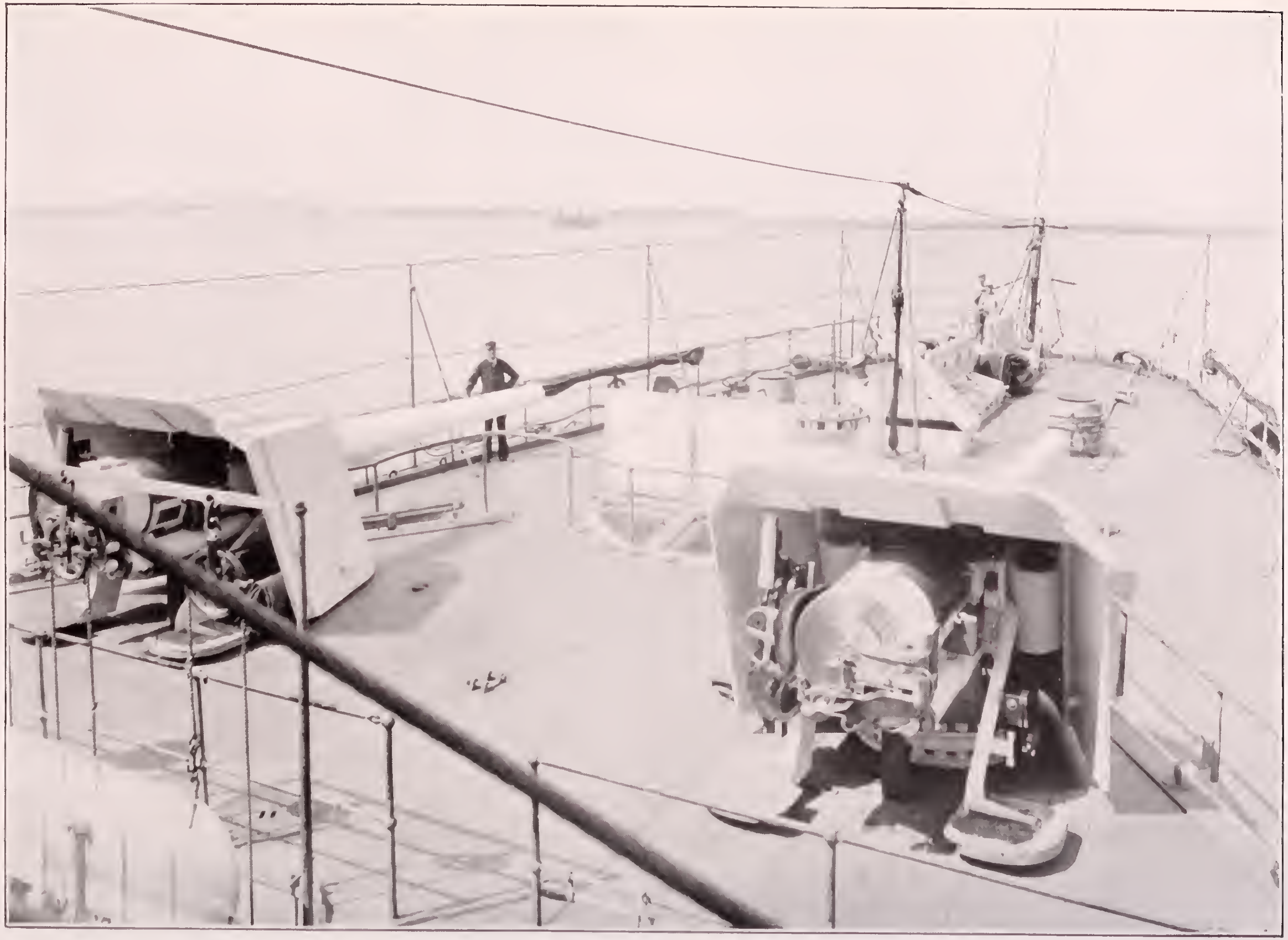
Coal capacity at load draught, 1,000 tons; I. H. P., estimated, natural draft, 16,500; I. H. P., estimated, natural draft, *Spartiate*, *Ariadne*, *Amphitrite*, and *Argonaut*, 18,000; speed, estimated, *Spartiate*, *Amphitrite*, *Argonaut*, *Adriadne*, 20.75 knots; *Andromeda*, *Diadem*, *Europa*, *Niobe*, 20.5 knots.

Funnels, fore and aft, 4; pole masts, 2; no poop.

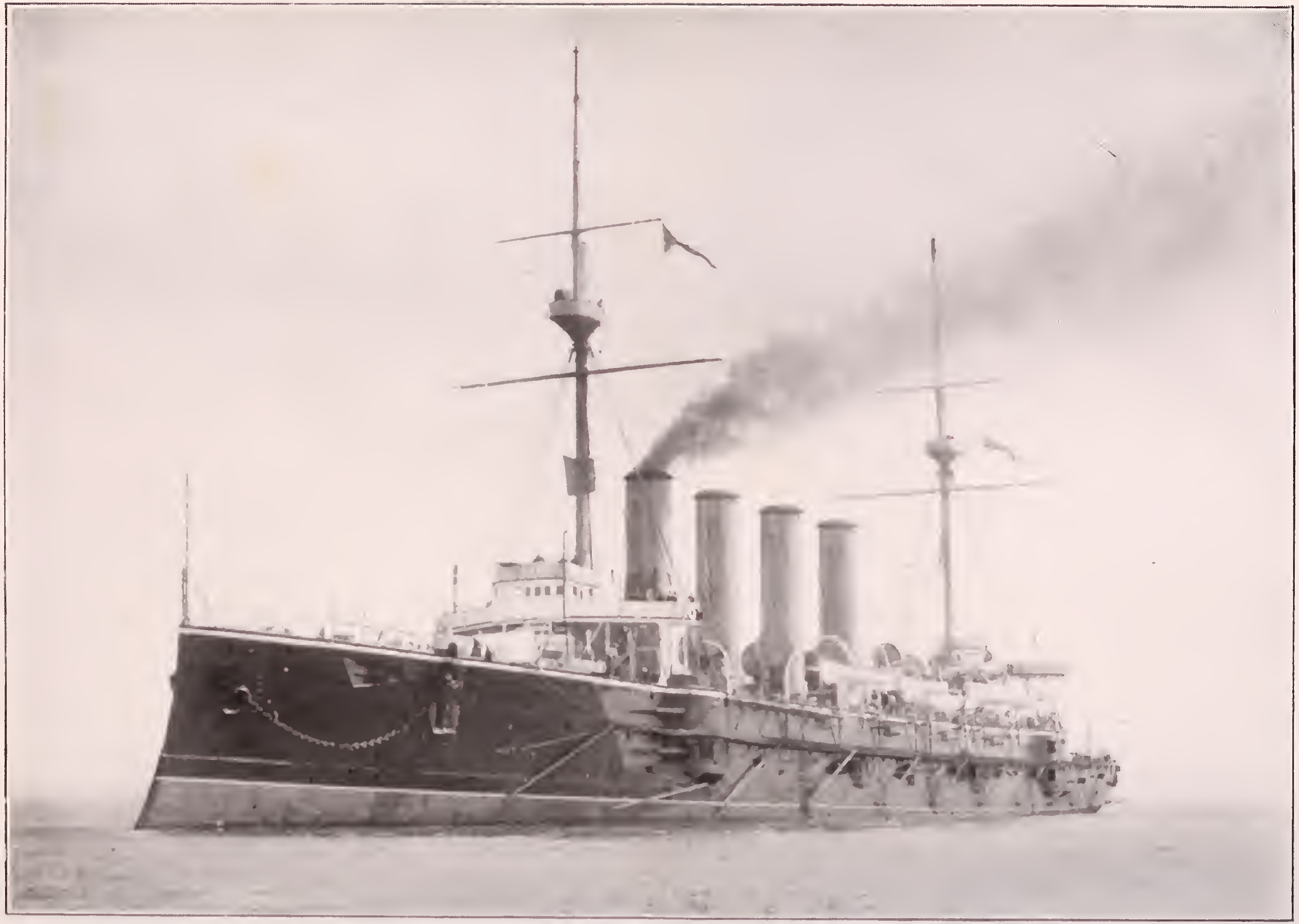
Armament.—The *Diadem* has an armament of sixteen 6-inch R. F. guns—two in separate shields upon the quarter-deck, two in separate shields upon the forecastle, four in corner casemates upon the upper deck, while the main deck has four of these R. F. guns in corner casemates immediately beneath the upper-deck casemates and four more in broadside casemates along the beam. There are fourteen 12-pounder R. F. guns—eight in the upper-deck battery, the remainder forward and aft upon the main and upper decks. There are also two 12-pounder field guns, R. F., which can be employed to fire over the breastwork forward. Three 3-pounder boat R. F. guns and a number of Maxim guns are mounted along the sides of the boat decks, on the bridge, and superstructure. Two submerged torpedo tubes are placed forward on either bow below the armored deck. A third above-water torpedo tube was originally designed, but the aperture has been closed up, as no more above-water torpedo tubes are now to be employed on battleships and cruisers. The *Diadem* has no fighting tops, so there



ARROGANT (British cruiser): 5,800 tons; I. H. P., 10,000; speed, 19.1 knots; launched 1896.



DIADEM. (British cruiser.) Quarter-deck.



DIADEM. (British cruiser.) 11,000 tons, I. H. P. 16,500, speed, 20.5 knots, launched 1896.

is no opportunity for the employment of 3-pounder quickfirers which are placed in such positions in other vessels.

Protection.—The protective deck, which extends all fore and aft, is of a curved form in section, ranges in thickness from 4 inches to 2½ inches, and covers the whole of the machinery, boilers, and magazines. A conning tower formed of Harveyized steel is placed forward, and fitted with apparatus for controlling the steering gear and directing operations while in action. The connections from the steering standards, etc., in the conning tower are all protected by a thick steel tube extending down to the protective deck. A director tower is also fitted aft for firing the torpedoes.

The main and upper deck casemates for the 6-inch quick firers are covered with armored shields of 6-inch Harveyized steel, equivalent to about 15 inches of ordinary wrought iron in resisting power to the penetration of projectiles.

The forward and aft guns (6-inch), which have an almost all-round fire, are mounted within steel shields 6 inches thick in front and thinning off towards the rear, of large size, but not large enough to protect the guns' crews, who would be terribly exposed, as well as the two hoists for whipping up the ammunition, which are not under cover.

Motive power.—The propelling engines of the *Diadem* consist of two completely independent sets of four-crank triple-expansion inverted-cylinder type; two low-pressure cylinders being fitted. The diameters of the cylinders are as follows: High pressure, 34 inches; intermediate pressure, 55½ inches; two low pressure, each 64 inches. The stroke is 4 feet, with a designed cut-off in the high-pressure cylinder of 73 per cent. The ratio of low-pressure to high-pressure cylinder volume is 7.08. Allowing for a clearance in the high-pressure cylinder of 25 per cent and in the low-pressure cylinder of 15 per cent, the designed real ratio of expansion at full power is about 8.3. The ratio of low-pressure to high-pressure cylinder volume in the *Powerful* is only 5.7 to 1. The superiority of the ratio given by the *Diadem's* engines, as just quoted, may account in some measure for their superiority in working. The maximum pressure at which the engines were specified to work was 250 pounds per square inch, with a boiler pressure of 300 pounds—an increase of 40 pounds beyond that specified for the *Powerful* and *Terrible.*

Steam will be supplied by an installation of 30 water-tube boilers of the Belleville type arranged in four groups, each group fitted in a water-tight compartment. Air-compressing steam engines are fitted in each stokehole to supply air to the furnaces, and the necessary air for ventilation will be delivered by eight large fans. Fans will also be fitted for engine room and ship ventilation. The ship will in all respects be complete, with every modern improvement.

STEAM TRIALS.

The following is a brief recapitulation of the result of steam contractor's trials with the *Diadem:*

Description of trial.	Date.	Number of boilers used.	Grate area used.	Heating surface used.	Coal per hour per I. H. P.	Speed.
			Sq. ft.	*Sq. ft.*	*Pounds.*	*Knots.*
30 hours' coal consumption	Jan. 18–19	8	392	10,820	2.18	12.74
30 hours' coal consumption	Jan. 21–22	30	1,462	40,550	1.59	19.79
8 hours' full power	Jan. 26	30	1,462	40,550	1.76	20.72

One of Napier's powerful windlass and capstan arrangements is provided forward for working the cables, and a steam warping capstan by the same makers is also fitted at the after end.

A refrigerating plant and cold chambers for provisions, etc., are also provided in this vessel.

CRUISERS, FIRST CLASS (ARMORED).

CRESSY, ABOUKIR, HOGUE, SUTLEJ, EURYALUS, AND BACCHANTE.

SHEATHED AND COPPERED.

(Page 17, No. XVII, Part I.)

	Built at—	Begun—	Launched—
Cressy	Fairfield	Oct. 12, 1898	Dec. 4, 1899
Aboukir	do	Nov. 9, 1898	
Hogue	Barrow	July 14, 1898	
Sutlej	Clydebank	Aug. 15, 1898	Nov. 18, 1899
Euryalus	Barrow	——, 1899	
Bacchante	Clydebank	——, 1899	

Dimensions.—Length between perpendiculars, 440 feet; beam, 69 feet 6 inches; draught, mean, 26 feet 3 inches; displacement, 12,000 tons.

Armament.—Two 9.2-inch B. L.; twelve 6-inch R. F.; fourteen 12-pounder R. F.; six smaller R. F. and machine; two submerged torpedo tubes.

Coal capacity, load draught, 800 tons; I. H. P., estimated, natural draft, 21,000; speed, estimated, 21 knots; funnels, fore and aft, 4; masts, with search-light tops, 2. Cost, about £650,000.

Armament.—The main armament will resemble that of the *Powerful* rather than that of the *Diadem*. The *Cressy* class will have a 9.2-inch 22-ton gun firing ahead and one astern, mounted in barbettes with 6-inch armor and protected by shields. The *Cressy* cruisers will do effective duty when chasing an enemy or fighting in the line, for both guns have a large arc for broadside attack. Four 6-inch quick-firing guns are to be arranged in casemates to fire ahead in line with the keel, and four to fire astern, and these also can fire on the broadside at almost any angle. There are also to be four guns amidships on the main deck, two on either side. There are, in addition, to be distributed throughout the ship twelve 12-pounders and a large number of machine guns.

Protection.—The difference in displacement between the new cruisers and the *Diadem* is due to the extra armor carried. The total will amount to 1,200 tons. The *Diadem* has all her guns as effectively protected with nickel steel as the *Cressy* class, and as the hull of the *Cressy* class will weigh 7,860 tons, or 885 tons more than that of the *Diadem*, the additional weight may be regarded as entirely due to the armor. The broadside armor will consist of a belt 11 feet 6 inches deep, extending 5 feet below the water line and 6 feet 6 inches above it. This armor, which is to be 6 inches thick, will extend for a length of 230 feet, terminating 120 feet from the bow and 90 feet from the stern in thwartship bulkheads 5 inches thick. The coal bunkers are to be arranged on either side of the boiler rooms under and over the protective deck (2 to 3 inches thick), and, as in all ships now built, an ammunition passage is to be arranged immediately under the protective deck. There is to be a thwartship bunker right forward.

Motive power.—In the arrangement of boilers again the *Cressy* cruisers resemble the *Diadem* rather than the *Powerful*. In the *Cressy* class the four boiler compartments will take up 130 feet of the length of the ship, as against 132 feet in the *Diadem* and 186 feet in the *Powerful*, but there is not much difference in the size of the engine rooms. There will be 30 boilers of the Belleville type fitted with economizers, as in all later ships, an arrangement which gives great economy in the *Diadem*. In the forward boiler room there will be six generators, and the three other boiler rooms will have eight apiece. The boilers have been designed with the same liberal steam-generating surfaces as in the *Diadem* class, so that no difficulty will be experienced in obtaining the full power—and even a little more should it be of any utility—and at the same time a higher power will be obtained per ton of machinery than could have been realized with the ordinary boilers. The working pressure will be 300 pounds per square inch, reduced to 250 pounds at the engines. The latter have been arranged to give 21,000 indicated horsepower, and the cylinders will be of the following diameters: One high pressure of 36 inches, an intermediate of 59 inches, and two low pressures, each of 68 inches, while the stroke will be 48 inches. At full power the engines will make 120 revolutions, so that, except that they are a little larger, they resemble closely those of the *Diadem* and *Ariadne* classes, which were designed to develop 18,000 indicated horsepower. The speed of the new cruisers is to be 21 knots, which should easily be realized.

The vessels will have four funnels and two masts, with a top on each for carrying search lights (but no guns), and with the usual semaphore. There will be the same arrangement of decks in all three classes.

DRAKE, LEVIATHAN, AFRICA, AND KING ALFRED.

NOT SHEATHED AND COPPERED.

	Built by—	At—	Begun—
Drake		Pembroke	Apr. 24, 1899
Leviathan	Clydebank	Glasgow	
Africa	Fairfield	do	
King Alfred	Vickers	Barrow	Sept. —, 1899

Dimensions.—Length between perpendiculars, 500 feet; beam, 71 feet; draught, mean load, 26 feet; weight of hull, 8,500 tons; displacement, 14,100 tons.

I. H. P., 30,000; speed, estimated, 23 knots; coal capacity at load draught, 1,250 tons; coal capacity, full bunkers, 2,500 tons.

Armament.—Two 9.2-inch B. L. wire guns; sixteen 6-inch B. L.; fourteen 12-pounders; three 3-pounders; two submerged torpedo tubes.

Protection.—Armor: Belt, 6 inches; gun position, 6 inches; deck, 2 to 4 inches.

The four cruisers of the *Drake* class, of which one has been ordered from Messrs. Vickers, Son & Maxim, of Barrow, one from the Fairfield Company, and one from Messrs. Thompson, of Clydebank, the builders in each case supplying the machinery, while the fourth is to be built at Pembroke, the machinery being supplied by Messrs. Humphry, Tennant & Co., were thus described by Mr. Goschen in his statement of July 22, 1898:

> They will be superior in speed and armament to the *Cressy* class and of larger dimensions. The protection to the 9.2-inch and 6-inch quick-firing guns will be equal to that of the *Powerful* class. The guns will be of the more modern type adopted for the *Cressy* class, and of considerably greater power than those of any other cruiser. There will be four more 6-inch guns than in the *Cressy*. Buoyancy and stability will be protected by vertical side armor about 6 inches thick, associated with strong steel decks. In these features the arrangements will be similar to those of the *Cressy* class and the *Canopus* class, but the bows will be more strongly defended. The steel hulls will be unsheathed. The measured-mile speed on an eight hours' trial with natural draft will be 23 knots. The continuous sea speed with smooth water will be 21 knots. Water-tube boilers will be adopted and twin screws. The capacity of the coal bunkers will be 2,500 tons, and 1,250 tons will be carried at the speed trials.

KENT, ESSEX, MONMOUTH, AND BEDFORD.

NOT SHEATHED AND COPPERED.

In the spring of 1899 the Admiralty accepted the tender of the London and Glasgow Engineering and Shipbuilding Company (Limited) for the building of a first-class cruiser to be named the *Monmouth*, and of the Fairfield Shipbuilding and Engineering Company

(Limited) for another to be named the *Bedford*. Two others of the same class are to be built, the *Kent*, to take the place of the *London*, on the building slips at Portsmouth dockyard, and the *Essex*, at Pembroke.

These vessels are specially interesting, it is said, as they are the prototypes of a new class, in which it is sought to secure a fair measure of protection by means of side armor without making the dimensions excessive, and yet without forfeiting to any appreciable extent any of the other qualities of strength, coal endurance, and fighting power. The new cruisers are what might be termed modified *Cressys*. Thus, while the length is the same as in the case of the vessels of the *Cressy* class—440 feet—the beam is 66 feet instead of 69 feet 6 inches, and the draught is 24 feet 6 inches rather than 26 feet 3 inches.

The design of the hull of the new cruisers will very closely resemble that of the *Drake* in its general features. Both types will have all the advantages which great length affords as a contributory factor in the development of high rate of speed, without the disadvantages which ordinarily attach to it for steerage purposes. At load draught the vessels will have a level keel for about three parts of their length in the central part, but from the points where that portion of the keel terminates, at either end, it slopes upward almost in a straight line to the stem and sternpost, respectively, the rise in both cases being considerable. This feature reduces the amount of resistance to turning, and thus vastly increases the handiness of the vessels. To further improve their steering qualities, a balanced rudder, which will extend to the depth of the level portion of the keel, and one part of which will work under the keel, will in each case be fitted.

The displacement of these vessels is estimated at 9,800 tons, their indicated horsepower at 22,000 and the speed 23 knots. Thus their displacement is 2,200 tons less than that of the *Cressy* class, their horsepower 1,000 greater, and their speed 2 knots greater, the relation of horsepower to displacement being nearly 2.25 I. H. P. per ton in the new vessels and 1.75 in the *Cressy* type. Instead of there being a saving in weight of machinery, there is an increase to the extent of 50 tons. The principal saving is really in armor and in gun weights. The less total displacement enables the beam to be reduced without adding to the draught, which is rather decreased. It follows that with a less beam there is a great saving in structural weight, while at the same time the propulsive efficiency is probably greater.

The armament will consist of fourteen 6-inch rapid-fire guns, four mounted by pairs in two turrets, one forward and one aft; of the others, which are mounted in armored casemates, four fire ahead, four astern, and five on each broadside. Each minute, therefore, 48 projectiles, each of 100 pounds weight, may be fired after a retreating foe at a muzzle energy of 500 foot-tons. The same performance can be executed at the stern should these vessels have to exercise discretion in getting out of the way of a more powerful opponent, while in a stand-up fight 72 shots per minute can be fired from each broadside, there being five guns on each side, with the two pairs of barbette guns. In addition there will be ten 12-pounder rapid-fire weapons, three 3-pounder rapid-fire, and eight Maxim machine guns. As in all later ships, the torpedo tubes will be entirely submerged, and there will be one on each broadside.

The steel hulls will be unsheathed. The vertical side armor, 4 inches in thickness, extends from the ram to within something like 100 feet of the stern, but toward the bow it is reduced to 3 inches, and then to 2 inches. As in all the armored cruisers, it extends from about 5 feet below the load water line to the fighting deck, above which there are casemates around the 6-inch rapid-fire guns, while the two central guns forward and aft are in barbettes protected by armor of the same thickness as the side armor. The armor is face-hardened steel.

The vessels will have two protective decks, the lower one being given considerable curvature. It will extend the whole length of the ship, and will form the shelf at the sides on which the vertical side armor will rest. A transverse vertical-armor bulkhead, also built on the lower protective deck, will cross the ship abaft the engine room, and the side armor will extend from it to the bows, thus inclosing what might be termed a huge armored citadel. All this armor will terminate above at the next deck, which will be formed of two thicknesses of plate, for additional protection.

The space between these two decks above the boiler and engine rooms will form the reserve coal bunkers, and these, when full, will add a further protection to that portion of the hull equivalent to an extra coating of armor 6 inches thick on the sides. The athwartship armor bulkhead will be 4 inches in thickness. The lower casemates will be erected on the upper protective deck as a foundation, the thickness of the front plates being 4 inches.

The protective deck is much lighter than in the *Cressy*, being from 2 to 4 inches thick.

Although there has been a general call for reduction in weight all round, it has not penetrated to the stoke hold or engine room. The allowance calls for only 12.5 I. H. P. per ton of machinery—about the same as in the *Cressy* class, and even slightly less than in the 23-knot cruisers of the *Drake* class, which, partly by reason of their greater length, are to be driven at the same speed for a less power per ton of displacement. The new engines partake pretty much of the same characteristics as the machinery of the *Cressy*. The cylinders will have 1 inch more diameter. There will be four of them, the intermediate exhausting into two low-pressure cylinders, but owing to the decrease in the draught of the ship and the less room under the protective deck it has been considered necessary to still further reduce the stroke of the engines, bringing the number of revolutions up to 140, which for vessels of such great size and power is unique. The *Diadem's* were designed to run at 110, and the *Cressy's* at 120 revolutions only. The stroke has been reduced to 42 inches instead of 48 inches in all the later cruisers.

There will be one more boiler than in the *Cressy*—31 of the Belleville water-tube type. The heating surface will be just over 50,000 square feet, the allowance per unit of power being 2.29 square feet. This is the lowest yet allowed.

The coal-stowing capacity will be 2,500 tons, sufficient, it is calculated, to take the vessel a distance of 20,000 miles at a rate of 10 knots an hour.

The normal bunker capacity will be 1,250 tons, and with this amount the contractors have guaranteed 23 knots an hour for eight hours at the trials, and for continuous steaming in an ordinary sea it will be possible to maintain a speed of 21 knots.

RUSSIA.

SHIPS BUILDING.

Battle ships.

OREL, BORODINO, AND IMPERATOR ALEXANDER III (PROBABLY A SISTER SHIP).

These are first-class battleships, building at St. Petersburg, at the following yards, respectively: Galerny Island, New Admiralty, and Baltic. They are a slight enlargement of the type of the *Tsarevitch*, building at La Seyne, in France.

Their dimensions are as follows: Length, 397 feet; beam, 76 feet; draught on an even keel, 26 feet; displacement, 13,600 tons.

Armament.—Four 12-inch guns coupled in turrets; twelve 6-inch guns; twenty 3-inch guns; about twenty-six smaller guns.

Protection.—Armor belt 7 inches thick in upper part, 9 inches in the middle, and 4 inches in the lower part. Special protection against torpedoes, 1.56 inches thick. Armor on turrets, 10 inches thick, Krupp steel. Bulkheads and an armored deck.

Motive power.—Their engines will develop 16,000 horse power, to give a speed of 18 knots. Boilers of Belleville type. Twin screws. Coal capacity, extreme stowage, 2,000 tons.

POBIEDA (VICTORY).

Laid down in the spring of 1899 at the Baltic Yard, St. Petersburg.

Battleship. Displacement, 11,362 tons; length at load line, 425 feet; extreme beam, 71 feet; draught on even keel, 26 feet. The *Pobieda* is a sister ship to the *Osliabia* and *Peresviet*, and took the place on the stocks vacated by the latter. She will not stand so high out of the water as the two other vessels, and there will be one or two minor differences.

Speed, 18 knots.

RETWISAN.

Building by Cramp, at Philadelphia.

Dimensions.—Length, between perpendiculars, 376 feet; beam, extreme, 72 feet 2.5 inches; draught, not to exceed 26 feet; displacement, about 12,700 tons.

Armament.—Four 12-inch; twelve 6-inch R. F.; twenty 3-inch R. F.; two 2½-inch R. F.; twenty 47 mm. R. F.; six 37 mm. R. F.; six torpedo tubes.

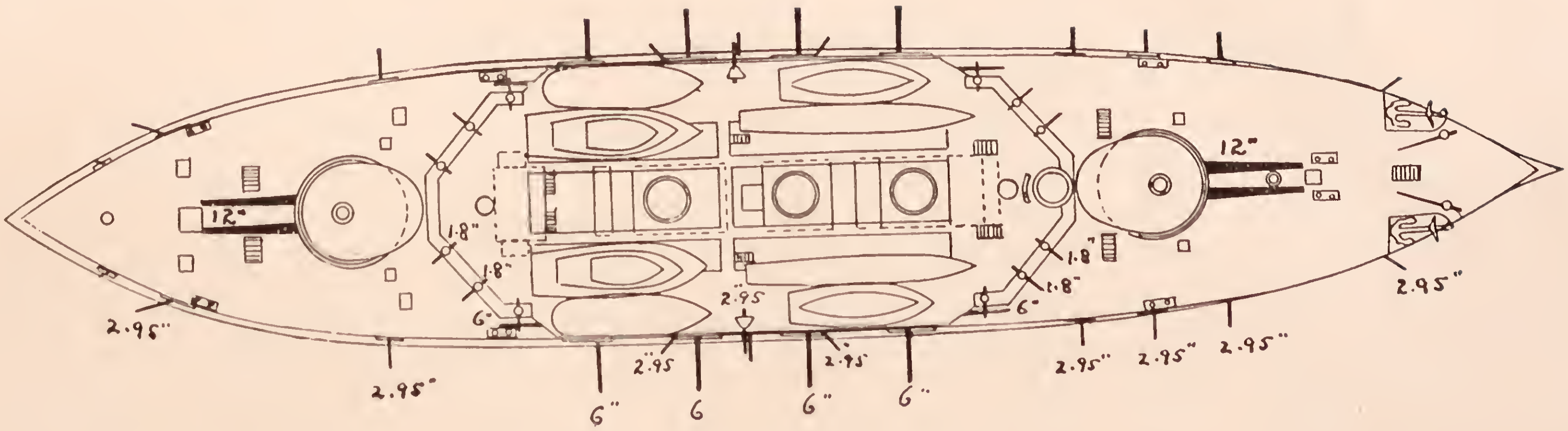
Full coal supply, 2,000 tons; I. H. P. to be 16,000; speed, at full displacement, for 12 hours, 18 knots; complement, about 750; funnels, 3.

General description.—This ship may really be described as a Russianized version of the *Maine*, *Missouri*, and *Ohio*, recently authorized by the United States. In the matters of comfort and convenience for the complement the ship will be typically American. There will be a very extensive drainage and ventilation outfit. The ship will be lighted throughout by electricity and will carry six large search lights, four of which will be placed upon the bridges and two others up in the tops of the military masts. The ship will carry two second-class torpedo boats.

Hull.—The hull is of steel, unsheathed, and supplemented by the usual inner bottom, extending fore and aft throughout the greater part of the vessel and reaching up to the armor shelf at the bottom of the water-line belt. This inner-bottom space may be used in part for liquid fuel, and provision is also to be made for the carriage there of feed water if needful.

Protection.—The hull is protected from attack, first, by a 7½-foot water-line belt, extending from abreast the after barbette forward to the stem. At normal draught, 4 feet of the belt below water. This belt is 9 inches thick and for two-thirds its total length maintains its maximum thickness. Forward of the maximum thickness the belt gradually tapers to 2 inches at the stem.

Above the water-line armor and up to the line of the first gun deck the sides are reenforced by a continuous band of 6-inch armor. The gun casemates are 5 inches thick about the guns of the midship batteries on both decks. The protective deck extends from bow to stern. In wake of the heaviest portion of the water-line belt the slopes of this deck, which terminate against the lower edge of the water-line armor, are 3 inches thick, while the flat is 2 inches thick. Forward and abaft this region the slopes are increased to 4 inches, the



RETWISAN (Russian battle ship) 12,700 tons.

midship flat section remaining still 2 inches. Following the line of the ends of the superstructure, diagonal athwartship bulkheads of 9-inch steel extend from the protective deck to the gun deck and from the gun deck to the main deck, completely blocking a raking fire. All of the armor will be treated by the Krupp process. Coal, of course, is stowed in the wake of the water-line armor and on top of the protective deck, affording just that much more protection against shot or shell.

Armament.—The four 12-inch guns, which will be of 40 calibers, will be mounted in two turrets, one forward and one aft of the central superstructure and on the same deck. At present the design of the turret is of the Russian type, but there is every probability that the turrets will eventually be similar to those for the *Maine* and her sister ships. At present the turrets and barbettes shown have a continuous thickness of 10 inches, and the guns have an arc of fire of quite 340 degrees. The 6-inch guns, which will be of 45 calibers, are to be mounted on the gun and the main decks. Eight—four in each midship battery—will be placed amidships on the gun deck. These guns are placed in rectangular sponsons and have each an arc of fire of 120 degrees. Heavy cylindrical shields are placed on the guns. The four remaining 6-inch guns are mounted on the main deck at the corners of the superstructure, where their arcs of fire are about 180 degrees. The 3-inch guns are mounted, twelve on the gun deck forward and abaft the 6-inch battery, six on the main deck between the 6-inch batteries again, and two—one on each side—amidships upon the bridge deck. The rest of the small guns are placed forward and aft on the bridges, the bridge deck, and up in the tops. The six torpedo tubes are disposed, one at the bow, one at the stern, and four—two on each side—amidships. The broadside tubes, so it is said, are to be of the under-water type.

Ammunition supply.—Elaborate arrangements provide for a continuous supply of ammunition to the rapid-fire guns. The turrets, all ammunition hoists, and many of the auxiliary machines will be operated by electricity.

Motive power.—Engines: The ship will be driven by two triple-expansion engines, in separate water-tight compartments, actuating twin screws. They will be of the three-cylinder type, and the diameters, respectively, for the high, intermediate, and low pressure cylinders will be 38½ inches, 59 inches, and 92 inches, with a common stroke of 42 inches. The collective indicated horsepower of the engines for the air and the circulating pump engines, and for the main engines when the latter are making something like 126 revolutions a minute, will be 16,000. This is to be kept up continuously for a trial of twelve hours, and that under natural draft. The high-pressure cylinders are forward and the low-pressure cylinders aft. The main valves will be of the piston type, worked by Stevenson link motions with double bar links. The valve gear of these cylinders will be made interchangeable as far as possible. There will be one piston valve for each high-pressure cylinder, and two for each intermediate-pressure cylinder. Each low-pressure cylinder will have four piston valves. The crank shafts will be made in three sections and interchangeable. The cranks will be 120 degrees apart. All crank, line, and propeller shafting will be hollow. Each main condenser will have a cooling surface of about 9,600 square feet, measured on the outside of the tubes, the water passing through the tubes. Each engine room will have an auxiliary condenser having not less than 800 square feet of cooling surface.

Boilers: Steam will be supplied by twenty-four water-tube boilers of the Niclausse type, constructed for a working pressure of 250 pounds per square inch, reduced to 200 pounds at the high-pressure cylinders. The boilers will be placed in four water-tight compartments, and there will be two double and two single ended fire rooms. The total amount of heating surface will be about 58,104 square feet, and the total grate surface will be about 1,353 square feet. There will be twenty-four furnaces, with seventy-two fire and ashpit doors, fitted with the latest and best designs of the Messrs. Niclausse. The boilers are to be of iron, malleable iron, cast iron, and steel. Ordinary cast iron will not be employed in parts subject to steam pressure. Pipe fittings and cocks will be of bronze. The steam drums will be made of mild steel of ample thickness for a working pressure of 256 pounds and will be fitted with plates for receiving the collectors or headers, which will be of malleable iron thoroughly annealed and subject to a hydraulic pressure of 400 pounds per square inch before being incorporated into the boilers. The boiler casings will be complete in sheet steel and angle bars, with coverings of magnesia or some other approved non-conducting material. They will be fitted with grate supports, ashpits, doors for sweeping tubes, balance fire doors closing automatically, balance ashpit doors, and all similar approved features. The chimneys, of which there will be three, will reach to a height of 100 feet above the grate bars.

CRUISERS.

DIANA.

(Page 78, No. XV; page 30, No. XVII, Part I.)

Building at Galerny Island Yard, St. Petersburg; laid down July, 1896; launched October 13, 1899.

PALLADA.

Same builders; laid down with *Diana;* launched August 20, 1899.

AURORA.

Building at New Admiralty Yard, St. Petersburg; laid down June, 1897.

The original plans were several times modified, and cruisers of about 6,630 tons provided for. The vessels have high speed (20 knots), good coal supply, and are sheathed with wood and coppered.

Dimensions.—Length over all, 414 feet; length on water line, 406 feet; beam, 55 feet; draught, 21 feet; displacement, 6,630 tons; speed, 20 knots; I. H. P., 11,600; coal supply, normal, 972 tons; coal supply, full, 1,400 tons.

Armament.—Eight 6-inch 45-caliber R. F.; twenty (3-inch 12-pounder) R. F.; eight Hotchkiss 47 millimeter (1.85-inch).

Protection.—Protection is furnished by the customary curved deck and by coal. The deck extends the full length of the ship and dips down at the bow to join the ram point. The thickness of the deck is ½, 1½, 2 inches on the flat, and ½, 2½, 3 inches on the slopes. Above the protective deck the space included between it and the deck next above is much subdivided and forms a cellular body. Almost all of this space is occupied by coal. A passageway is found on each side of the central line between the line of the trunks about the funnels, the engine hatchways, etc., and the coal bunkers. It will be observed that there are no cofferdams filled with cellulose or like material. Coal is the obturating material preferred in the Russian navy. No protection by armor is provided in the new cruisers for the ship's sides, nor for the battery other than by gun shields.

Two conning towers are provided—one forward, one aft.

A double bottom extends throughout the entire length.

The free board forward to the forecastle deck is 26 feet 8 inches; aft to the main deck is 17 feet 9 inches.

Torpedo tubes above water on the berth deck; 1 in stem, fixed; 1 in stern, fixed; 2 in broadside, training. Projectors, probably 6; 1 is mounted on an outrigging platform in the bow (stem) port on main deck; the others are distributed about the hull in the usual manner.

Attention is called to the employment of the 47-millimeter R. F. battery on the lower deck. While an important addition to the ship's battery, its emplacement must hamper the efficiency of these small guns.

Magazines.—The magazines are located at the extremities, beyond the boiler and machinery spaces, and are also distributed along the sides in the coal spaces for the supply of ammunition to the broadside guns in the middle body.

Motive power.—Three sets of independent engines drive three screws. The engines are placed as in the *Columbia;* two abreast in a single transverse compartment separated by a longitudinal bulkhead, between frames 75 and 86–87, and the third engine on the central line, abaft, in a single compartment between frames 86–87 and 98. Belleville boilers arranged in four groups.

The engines are of the vertical triple-expansion three-cylinder type. They are each of equal force and will develop an aggregate of 11,600 I. H. P. and an estimated speed of 20 knots.

The plans of the vessel indicate four cylinder engines, but at the Franco-Russe works it was said that three cylinders only were to be used.

WARYAG.

Cruiser building by Cramp, at Philadelphia. Laid down, 1898; launched October 31, 1899.

Dimensions.—Length between perpendiculars, 400 feet; beam, 52 feet; draught, 19 feet 6 inches; displacement, 6,500 tons; speed for twelve hours, 23 knots.

Armament.—Twelve 6-inch R. F.; twelve 3-inch R. F.; six 1.8-inch R. F.; four torpedo tubes.

Motive power.—Twin screws, right and left, in separate compartments; engines of the vertical type, with inverted cylinders of direct action, with four cylinders, with triple expansion, to insure an easy speed of 23 knots. Boilers to be of the Niclausse type.

Hull not sheathed.

Complement, 580 officers and men.

Protection.—The protective deck, which will run from stem to stern, will be 1½ inches on the flat and 3 inches on the slopes.

The ship will be lighted by electricity, which power will also be used for many of the auxiliaries. Wood has been discarded as far as possible.

Eight of the 6-inch guns will be mounted in broadside on the main deck, the two forward and the two aft guns on either side being placed in sponsons, permitting a dead-ahead and straight-astern fire, respectively. The four remaining 6-inch guns will be mounted two each on the forecastle and on the main deck, abaft the after bridge. All will have considerable arcs of fire. All guns are protected by heavy gun shields. The above arrangement of 6-inch guns permits ahead and stern fire of four 6-inch, and abeam fire of six 6-inch. The twelve 3-inch guns are mounted on the main and berth decks; eight of them are placed amidships between the broadside battery of 6-inch guns; two others are placed well forward in sponsons, just under the forecastle, whilst the last two are mounted in sponsons, one on either side, well aft on the berth deck.

The small guns will be placed on the bridges and in the tops. The conditions of the steaming trials are particularly severe, the speed of 23 knots having to be maintained for twelve hours.

BAYAN.

Cruiser building at La Seyne by Les Forges et Chantiers de la Méditerranée.

Hull sheathed.

Dimensions.—Length over all, 445 feet; beam, 57 feet 1 inch; draught amidships, 22 feet 1 inch; displacement, 7,800 tons.

The hull is being constructed at the yard at La Seyne; the engines at Marseilles; the boilers at St. Denis.

Armament.—Two 8-inch (203-millimeter) in turrets fore and aft; eight 6-inch (152-millimeter) in casemates; twenty 3-inch (75-millimeter) in casemates; seven 47-millimeter machine guns.

Cost, 16,500,000 francs.

Protection.—Armor belt, 200 millimeters (7.88 inches) thick, tapering to 100 millimeters (3.94 inches); armor on turrets, 7.88 inches thick.

Motive power.—Two vertical four-cylinder triple-expansion engines, giving at 140 revolutions 16,500 I. H. P.; boilers of Belleville type. When ready, besides a six-hour trial at 14 knots, she will have a twenty-four hours' full-speed continuous run.

NOVIK.

Building by Schichau, at Elbing.

Dimensions.—Length, 347 feet 10 inches; beam, 40 feet; displacement, 3,000 tons.

Armament.—Six 4.7-inch guns.

Protection.—Complete protective deck, reaching 1.3 meters (4.27 feet) below water line; 30 millimeters (1.18 inches) thick on flat, 50 millimeters (1.97 inches) thick on slopes.

Motive power.—Triple-expansion engines, 17,000 I. H. P.; speed, 25 knots; 12 boilers, Schichau system.

BOGATYR.

Building by the Vulcan Shipbuilding Company, at Stettin.

ASKOLD.

Building at Germania Yard, at Kiel.

There are six of these cruisers, three building at St. Petersburg (*Pallada*, *Diana*, and *Aurora*), one at Philadelphia (the *Waryag*), one at Kiel (the *Askold*), and one at Stettin (the *Bogatyr*). They are not exactly alike, but the *Bogatyr* is typical.

Dimensions.—Length over all, 413 feet 6 inches; beam, 54 feet 4 inches; draught, 20 feet 8 inches; displacement, 6,500 tons.

Armament.—Twelve 6-inch; twelve 3-inch; six 1.4-inch Hotchkiss; torpedo tubes, six (two submerged).

Protection.—The principal gun positions will be protected by 5-inch to 3-inch nickel steel.

Motive power.—Two sets triple-expansion engines, with four cylinders each, supplied by Normand, developing 19,500 I. H. P., driving twin screws and giving speed of 23 knots. Water-tube boilers.

Normal coal supply, 720 tons; full bunker capacity, 1,100 tons.

Complement, 580 officers and men.

TSAREVITCH.

Battleship, to be built by the Forges et Chantiers de la Mediterranee.

Dimensions.—Length between perpendiculars, 388 feet 9 inches; greatest beam, 75 feet 5½ inches; depth in hold, 47 feet 10 inches; draught on even keel, 26 feet; displacement, 12,900 tons.

Armament.—Four 12-inch guns in turrets, fore and aft; twelve 6-inch guns, two in each side turret; twenty 7.5-centimeter (2.95-inch) in the main battery and on the upper deck; twenty-eight smaller guns; four torpedo tubes above water.

Motive power.—Engines, two, triple expansion, 16,300 I. H. P.; boilers, Belleville; coal supply, normal, 900 tons; maximum, 1,350; steaming radius at 10 knots, with indicated horsepower of 2,500, using 1.76 pounds of coal per indicated horsepower, 5,500 miles; maximum speed, not less than 18 knots.

CRUISER.

To to built at new Government shipbuilding yard at Windau.

Dimensions.—Length, 412 feet; beam, 53 feet 6 inches; draught, with full load, 20 feet 8 inches; displacement, 6,375 tons.

Armament.—Twelve 6-inch Canet guns, 45 caliber, two in fore and two in after turret, and eight in casemates; twelve 7.5-centimeter (2.95-inch) 50-caliber guns in battery; eight 47-millimeter (1.85-inch) Hotchkiss guns; five torpedo tubes; two under water broadside forward, three above water, two broadside aft and one right in the bows.

Motive power.—Two engines, developing 20,000 I. H. P.; twelve Normand boilers; three funnels, foremost furnace being right forward.

Deck protection 2 centimeters (0.787 inch) in thickness along whole length; freeboard, 20 feet 6 inches.

FRANCE.

IÉNA (BATTLESHIP).

NOT SHEATHED AND COPPERED.

(Page 168, No. XVI, Part IV.)

Builder.	Keel laid.	Date of launch.
Dockyard, Brest	Jan. 15, 1898	Sept. 1, 1898

Material of hull, steel; form of bow, ram; number of funnels, 2; rig, 2 masts, with military tops; complement, 600 men and 31 officers.

Dimensions.—Length, 405 feet 3 inches; extreme breadth of beam, 65 feet 11 inches on water line; draught, 27 feet 7 inches; displacement, 12,052 tons.

Cost, 27,856,496 francs ($5,376,303.73).

Armament.—Four 30.5-centimeter (12-inch); eight 16.4-centimeter (6.46-inch) R. F.; eight 10-centimeter (3.94-inch) R. F.; twenty 4.7-centimeter (1.85-inch) R. F.; four 3.7-centimeter (1.46-inch) R. F.; two 6.5-centimeters (2.56-inch). Two above-water and two submerged torpedo tubes.

Tactical data.—Search lights, six.

Protection.—Hull protection: Complete armor belt at water line; thickness, 320 millimeters (12.6 inches). Light armor over other works, 120 millimeters (4.72 inches). Transverse bulkheads, 120 millimeters fore and aft.

Protective deck: Two armored decks, one 4.72 inches thick, covering the motive and evaporating apparatus and extending from stem to stern, having no openings except for the boilers and hatches.

Motive power.—Engines: Three vertical triple-expansion, 15,500 I. H. P.

Boilers: Twenty Belleville (burn coal or petroleum).

Screws: Three.

Coal.—Capacity at load water line, 820 tons; total capacity, 1,100 tons; endurance at maximum speed, 1,100 to 1,500 miles; at 10 knots, 5,200 to 7,000 miles.

ARMAMENT.

Arrangement of guns differs from that hitherto observed in the disposition of the artillery of lately constructed French battleships. In the *Iéna* the heavy guns are disposed in pairs in turrets, and an armored redoubt has been adopted, while it was characteristic of all the later French battleships that every gun of large or medium caliber was mounted singly, either in a turret or other special armor protection, but always separately. Eighteen 37-millimeter machine guns, of which thirteen are revolving cannon. The profile of the sides of the new battleship also is such as to admit of four bow guns and four after guns of the calibers of 164.7 millimeters and 100 millimeters being trained ahead and astern.

Eight guns of 164.7 millimeters in armored redoubts firing through corner ports. Above these in corresponding positions upon the superstructures eight guns of 100 millimeters also firing, four ahead and four astern. There is therefore a total of sixteen guns of lesser caliber with rapid fire, of which half can always converge their fire upon the same target. 164.7-millimeter guns will receive shields of 70 millimeters and 100-millimeter guns shields of 54 millimeters. The five 37-millimeter guns will be for landings.

PROTECTION.

The protection of the hull will be assured by an elaborate division into compartments, a complete armor belt and two armored decks, as well as a slight belt over the upper works. The armor will be of case-hardened steel.

Protection of the upper works by the slight armor called cofferdam armor.

Complete belt, armor 320 millimeters; lesser armor, 120 millimeters; two armored decks horizontal, as well as redoubts for the lesser artillery, armored with 120-millimeter armor and closed by armored bulkheads of same thickness. Conning tower, hatches, and coamings armored.

Hull entirely of steel. Wood is banished even from the furniture.

Two armored decks, one at the lower, the other at the upper, edge of the belt armor. A second, slighter, belt rises above the principal deck. The thickness of the armor belt at the water line in the center does not exceed 35 centimeters, tapering toward the extremities, of cemented steel. It will rest on an oak backing 150 millimeters thick and a double plating of steel 11 millimeters thick. The slight armor above is composed of plates of 120 and 80 millimeters, and is higher at the forward end than in the middle and at the stern. It is also of Creusot case hardened steel.

Protected voice tube (weight 40 tons) and conning tower (weight 50 tons), with roof of 25 millimeters hardened steel.

The armored deck is of extra-mild steel, 65 millimeters maximum thickness.

Behind the principal belt armor are storerooms and numerous compartments for the auxiliary engines. Cofferdams extend within the lighter armor.

Twenty Belleville boilers in four compartments. Boilers furnished with economizers.

Eight feed pumps, Belleville type, placed in the boiler rooms, give a total delivery of 252 cubic meters of water per hour.

Ventilation of boiler compartments obtained by eight ventilators placed in the orlop deck, with power of 350,000 cubic meters per hour.

Two distillers, with capacity of 74,000 liters a day, are also placed on the orlop deck.

Mixed stoking with petroleum installed on the *Iéna*. The installation will comprise two Thirion pumps, with two chambers for petroleum and their steam piping; suction and force tubing, pulverizers, superheaters, etc.

The engines are furnished by the Forges et Chantiers de la Méditerranée. They are three in number, vertical inverted cylinder, with four cylinders and triple expansion, each actuating a screw. Together they develop 15,500 I. H. P. at 125 revolutions. With the auxiliaries, 15,800 I. H. P. Each engine is in a separate compartment, the three compartments making a line in the transverse direction. Each of them is furnished with an auxiliary apparatus comprising the surface condenser, an engine with two cylinders actuating two air pumps, in bronze, and a bronze circulating pump.

Turrets manœuvred electrically and by hand.

Ram bow less conspicuous than usual.

SUFFREN (BATTLESHIP).

NOT SHEATHED AND COPPERED.

Builder.	Keel laid.	Date of launch.
Dockyard, Brest	Jan. 16, 1899	July 25, 1899

Material of hull, steel; form of bow, ram; number of funnels 2; rig, 2 military masts, forward with 3, after 2, tops, upper tops for search lights; complement, 31 officers, 600 men.

Dimensions.—Length, 411 feet 9 inches; extreme breadth of beam, 70 feet 1 inch; draught, 27 feet 7 inches; displacement, 12,728 tons.

Cost, 29,492,887 francs ($5,692,127.19).

Armament.—Four 30.5-centimeter (12-inch); ten 16.4-centimeter (6.46-inch) R. F.; eight 10-centimeter (3.94-inch) R. F.; twenty 4.7-centimeter (1.85-inch) R. F.; four 3.7-centimeter (1.46-inch) R. F.; two 6.5-centimeter (2.56-inch); 2 above-water and 2 submerged torpedo tubes.

Tactical data.—Search lights, six.

Protection.—Hull protection: At water line a Harveyized steel belt from stem to stern; maximum thickness, 300 millimeters (11.8 inches); extending to a height of 1.10 meters (3.6 feet) above the water line, 1.4 meters (4.6 feet) below. Armor to a height of 2 meters (6.5 feet), 130 millimeters (5.1 inches) thick, protects the battery for the R. F. guns on the upper deck. Thus a considerable extent of side between the lower belt and the upper deck is left exposed to shell fire.

Double bottom, division into compartments, cofferdam.

Protective deck: At the level of the top of the armor belt; thickness, 70 millimeters (2.7 inches). Splinter deck, 40 millimeters (1.58 inches) thick.

Turrets, barbettes, redoubts: Conning tower, 270 millimeters (10.63 inches). Turrets fore and aft for 30.5-centimeter guns, 320 millimeters (12.6 inches); their bases have 280 millimeters (11 inches) hardened steel; turrets for 16.4-centimeter guns, 130 millimeters (5.12 inches) special steel; bases the same; turret turning gear protected by 100-millimeters; casemates for 16.4-centimeter guns, 130 millimeters (5.12 inches) special steel. Ammunition hoists for 16.4-centimeter guns armored. Communication tubes, 150 millimeters (5.9 inches) special steel.

Motive power.—Engines: Three vertical triple-expansion, total I. H. P. 16,200, speed (estimated) 18 knots.

Boilers: Twenty Belleville water-tube. (24 Niclausse; *l'Illustration*, July 22, 1899.)

Screws: Three.

Coal.—Capacity at load water line, 820 tons; total capacity, 1,150 tons; endurance at maximum speed, 1,000 to 1,500 miles; at 10 knots, 5,100 to 7,000 miles.

ARMAMENT.

Four 30.5-centimeter (12-inch) guns, two forward, two aft, coupled in two barbette turrets, turning through about 270 degrees, mounted on the main deck, the forward barbette being higher than the after barbette. Ten 16.4-centimeter (6.46-inch) R. F. guns, six mounted in barbette turrets on the main deck (of these the two forward have direct-ahead, the two just aft of the middle have direct-astern, and the two just forward of the middle have fore and aft fire), and four in armored casemates on the gun deck, two just abaft forward funnel firing ahead, and two in line with after funnel have stern fire. Eight 10-centimeter (3.94-inch) R. F. guns, four on the upper deck just forward and abaft a point above the center turrets of the 16.4-centimeter guns on the main deck, two on the after part of the bridge deck, firing over the after 30.5-centimeter gun turret, and two on the lower bridge forward; of these, four fire ahead, four astern, and four on each broadside. Twenty 4.7-centimeter (1.85-inch) R. F. guns; of these, four are in ports under the forward barbette on the gun deck, four in ports aft, two on the bridge deck forward, firing over the forward turret amidships, two on the upper deck aft, and the rest in the military tops. Four 3.7-centimeter (1.46-inch) R. F. guns on the corners of the upper bridge forward. Two 6.5-centimeter (2.56-inch) guns for landing purposes.

All guns above and including the 37 millimeter are in towers or protected by shields.

PROTECTION.

The main belt armor is surmounted, over the entire height between decks situated above the protective deck, by a lesser armor of special steel 130 millimeters thick in the middle. This armor extends from the stem to a bulkhead at the stern, its thickness decreasing slightly toward the ends.

All ladders are surrounded above the protective deck by armored drums or barrels, giving protection to the lower compartments against the invasion of water.

TORPEDO ARMAMENT.

Two submerged tubes forward; two above water forward on the protective deck. Ship carries 12 torpedoes.

ELECTRIC INSTALLATION.

For lighting, pumping, ventilation of engine rooms, boiler rooms, and various places, turning the turrets, and hoisting ammunition electricity is used; the central station can furnish a normal amount of 5,400 amperes, and in case of necessity 6,750.

COMPLEMENT.

790 men, with the staff of the vice-admiral, 46 officers; without the staff of the vice-admiral, 714, including 34 officers.

CONDÉ AND CLASS.

NOT SHEATHED AND COPPERED.

Name.	Descriptive and explanatory remarks.
Condé and class	Armored cruisers, modified Montcalm type.

	Builders.	Keel laid.
Condé (ex-C 4)	Dockyard, Cherbourg	1899
Gloire (ex-C 7)	Dockyard, Lorient	1899
Marseillaise (ex-C 9)	Dockyard, Brest	1899
Sully (ex-C 8)	Forges et Chantiers de la Méditerranée, la Seyne	1899
Amiral-Aube (ex-C 10)	Brest	1899

Material of hull, steel; form of bow, ram (slight); number of funnels, 4; rig, military mast forward with two tops; signal mast aft; complement, 23 officers, 540 men (*Sully* and *Amiral-Aube*, 30+584).

Dimensions.—Length, 138 meters (452 feet 10 inches); extreme breadth of beam, 20.2 meters (66 feet 3 inches); draught, 7.55 meters (24 feet 9 inches); displacement, 10,014 tons.

Cost, $4,131,782 to $4,549,685.

Armament.—Two 19.4-centimeter (7.64-inch); eight 16.4-centimeter (6.46-inch) R. F.; six 10-centimeter (3.94-inch) R. F.; eighteen 47-millimeter (1.85-inch) R. F.; six 37-millimeter (1.46-inch) R. F.; two 65-millimeter (2.56-inch). Two above water and two submerged torpedo tubes.

Tactical data.—Searchlights, 6.

Protection.—Hull protection: Water-line armor belt, 9.84 feet above, 4.92 feet below, water line; thickness amidships 6.69 inches, forward

4.17 inches, aft 3.78 inches; soft stern. Lighter belt from stem to after end of forward 16.4-centimeter gun casemates extends to main deck; thickness 2.2 inches. Transverse bulkheads fore and aft, respectively, of the forward and after 16.4-centimeter gun casemates have 4.72-inch armor. Transverse bulkhead joining ends of armor belt at stern has 3.94-inch armor. Cofferdams; longitudinal and transverse bulkheads. All armor of Harveyized steel.

Protective deck: Main armored deck complete; on flat, at height of water line, 1.77 inches thick; on slopes, 1.77 inches thick, joining lower edge of vertical armor. Horizontal splinter deck, above at upper edge of main armor belt, in central part, 1.18 inches thick; forward, 0.787 inch thick.

Turrets, barbettes, redoubts: 19.4-centimeter gun turrets have 7.87 inches of armor; 16.4-centimeter gun redoubts or separate casemates have 4.72-inch armor; 16.4-centimeter guns carry armored shields; 10-centimeter R. F. guns carry armored shields; forward conning tower protected with 7.87-inch armor; after conning tower protected with 6.3-inch armor.

Motive power.—Engines: Three vertical triple-expansion engines inclosed in separate compartments, developing 20,500 estimated I. H. P., and giving a speed of 21 knots.

Boilers: Twenty-eight Niclausse water-tube boilers, to burn coal and petroleum.

Screws: Three.

Coal.—Capacity at load water line, 970 tons; total capacity, 1,590 tons; endurance at maximum speed, 1,230 to 1,940 miles; at 10 knots, 6,500 to 10,400 miles.

ARMAMENT.

Two 19.4-centimeter guns in two turrets, one forward, the other aft; eight 16.4-centimeter R. F., four in turrets, of which two are placed forward and two aft of the midship frame, on the upper deck, with broadside fire; the other four in armored redoubts, of which two are placed on the forecastle a little aft of the forward central turret, on the main deck, having direct fire ahead, and two upon the upper protective deck, below the after central turret, thus having direct fire astern; six 10-centimeter guns, R. F., two on the upper deck just above the forward redoubts of the 16.4-centimeter guns, two on the broadside amidships on the main deck, and two aft on the main deck, just above the redoubts or armored casemates of the 16.4-centimeter after guns, and having direct fire astern; eighteen 47-millimeter R. F. guns, four in the tops and the rest distributed in the battery, upon the deck and bridges; six 37-millimeter R. F. guns on the bridges; two 65-millimeter guns; two torpedo-launching tubes of 45 centimeters (17.72 inches).

These ships can therefore fire, speaking only of the main and secondary batteries: Ahead, one 19.4-centimeter guns, four 16.4-centimeter guns, and two 10-centimeter guns. Astern, one 19.4-centimeter guns, four 16.4-centimeter guns, and two 10-centimeter guns. On each broadside, two 19.4-centimeter guns, four 16.4-centimeter guns, and three 10-centimeter guns.

PROTECTION.

The armor belt, between the lower protective deck below the water line and the upper or splinter deck, is of the following thickness: In the middle, 170 millimeters (6.69 inches); forward, 106 millimeters (4.17 inches); aft, 96 millimeters (3.78 inches), and the armor is not continued around the stern.

The height of the upper edge of this belt above the water line is 3 meters (9.84 feet) forward, 2.3 meters (7.55 feet) in the middle, and 2.5 meters (8.2 feet) aft; the lower edge is 1.5 meters (4.92 feet) below water line. Above this belt a slighter armor, 56 millimeters (2.2 inches) thick, extends up to the main deck and is continued from stem to aft of forward 16.4-centimeter guns.

Protective decks.—The lower protective deck is inclined toward the sides; on the flat it is level with the water line, and drops down at the sides to join the lower edge of the vertical armor belt; it is 45 millimeters (1.77 inches) thick; the upper protective or splinter deck is horizontal, situated at the upper edge of the vertical belt, and its thickness in the central part is 30 millimeters (1.18 inches), decreasing to 20 millimeters (.787 inch) forward.

A transverse bulkhead, 100 millimeters (3.94 inches) thick, joins the ends of the armor belt at the stern.

All the armor is Harveyized steel.

Protection is further obtained by the cellular division of the space between the two armored protective decks by four longitudinal watertight bulkheads, thus forming five sections. The outer section on each side constitutes a cofferdam, divided into numerous compartments, filled with water-excluding material; inside these are two wing passages; and the inner section is also divided into many compartments, and the passages, funnels, ammunition hoists, ventilators, etc., which go up through it are protected at their bases by a cylinder of armor.

Gun protection.—The fixed and movable parts of the two turrets for the 19.4-centimeter guns are covered with 200 millimeters (7.87 inches) of armor; those of the four turrets for the 16.4-centimeter guns with armor 120 millimeters (4.72 inches) thick.

The redoubts or armored casemates for the 16.4-centimeter R. F. guns (one forward on the main deck, the other aft on the lower splinter deck) are closed, the one at the forward, the other at the after end, by transverse bulkheads with 120 millimeters (4.72 inches) of armor, and the mounts of their guns carry armored shields which reduce to a minimum the opening of the ports; thus these guns have a complete protection vertically beginning at the main protective deck.

The 10-centimeter R. F. guns carry armored shields in two parts, one fixed and the other turning with the gun.

Conning towers.—The forward conning tower is protected with 200 millimeters (7.87 inches) of steel, the after conning tower with 160 millimeters (6.3 inches).

After turret.—The spar deck (upper deck) is continued nearly to the stern, as in the *Gueydon* type, thus allowing the after turret to be placed at the same height as the forward turret.

MOTIVE POWER.

The motive apparatus consists of three vertical inverted cylinder triple-expansion engines, inclosed in separate compartments; total indicated horsepower, 20,500. The auxiliary engines are very numerous; for the ammunition hoists, exhausting pumps, ventilators, dynamos, etc., without counting the auxiliary apparatus proper of the engines.

The boilers are placed in four separate compartments, six in each of the end compartments and eight in each of the central compartments, making a total of 28 Niclausse water-tube boilers. In all, there are 352 elements, with 18 tubes in each. Total grate surface, 118.4 square feet. Total heating surface, 39,904.15 square feet. The total weight of the apparatus, including the patent fuel and water in boilers, is 369 tons, which places the weight at about 40 pounds to each horsepower.

Independently of the coal supply (970 tons) the ships will each carry cisterns to contain 80 tons of petroleum each.

GERMANY.

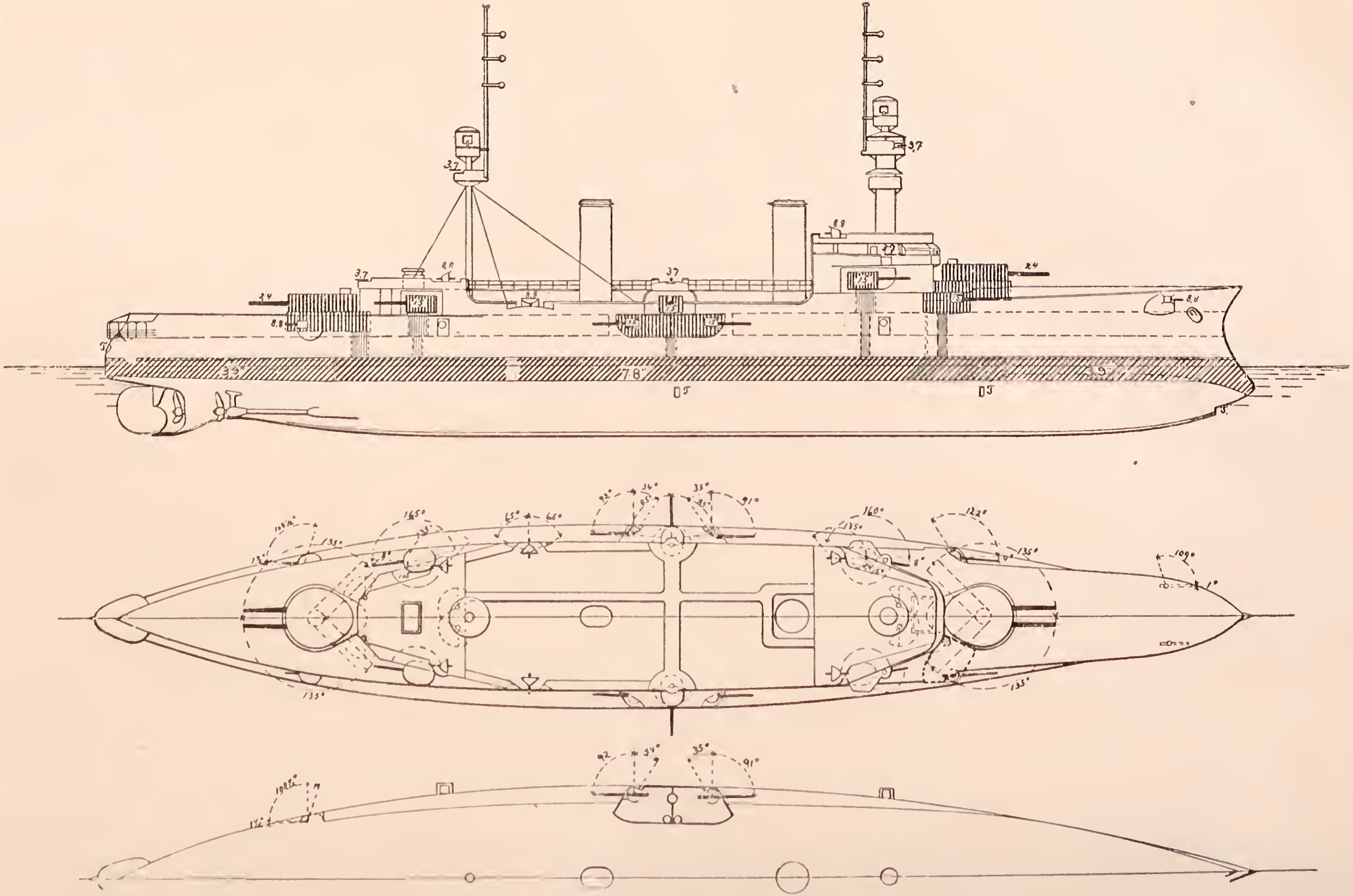
FÜRST BISMARCK.

(Page 30, No. XIV; page 42, No. XV.)

	Descriptive and explanatory remarks.
Fürst Bismarck (Ersatz Leipzig).	Armored cruiser, first class (under new German classification called "grosser kreuzer," i. e., large cruiser).

	Builders.	Keel laid.	Date of launch.
Fürst Bismarck	Imperial Shipyard, Kiel	Apr. 1, 1896	Sept. 25, 1897.

Material of hull, steel; teak-wood planking, copper sheathing. Form of bow, ram; number of funnels, 2; rig, 2 military masts, fighting tops, signal masts; complement, 568 (division staff, 43).



FÜRST BISMARCK. (German armored cruiser.) 10,650 tons

Dimensions.—Length, 393 feet 8 inches; extreme breadth of beam, 66 feet 11 inches; draft, mean, 25 feet 11 inches; displacement, 10,650 tons.

Cost, $4,112,640.

Armament.—Four 24-centimeter (9.45-inch) R. F. 40-caliber guns in barbette turrets; six 15-centimeter (5.91-inch) R. F. 40-caliber guns in separate armored casemates; six 15-centimeter (5.91-inch) R. F. 40-caliber guns in armored turrets; ten 8.8-centimeter (3.47-inch) R. F. 30-caliber guns with shields; ten 37-millimeter (1.46-inch) machine guns; four 8-millimeter (0.315-inch) machine guns, automatic. Torpedo: One 45-centimeter (17.72-inch) submerged bow tube; four 45-centimeter (17.72-inch) submerged broadside tubes; one 45-centimeter (17.72-inch) above-water stern tube, armored.

Tactical data.—Search-lights, six.

Protection.—Hull protection: Armor belt, 2.5 meters (8 feet 2 inches) high, extending all around, 7.87 inches thick, decreasing forward and aft to 3.94 inches; armored transverse bulkheads forward and aft, 3.94 inches thick; cork belt; armor material, hardened steel of superior quality.

Protective deck: Citadel extends six-tenths of the ship's length. Fore and aft of this a protective deck, varying from 1.97 to 1.18 inches in thickness, extends under water to the ends of the ship. Another protective deck of the same thickness extends above water from the stem to the stern, resting on the upper edge of the belt armor. A 0.79-inch splinter deck affords protection against light fragments.

Turrets, barbettes, redoubts: Twenty-four-centimeter gun turrets have armor 7.87 inches thick; 15-centimeter turrets, 3.94 to 3.15 inches thick; casemates, 3.94 to 3.15 inches thick; forward conning tower, 7.87 inches; after conning tower, 3.94 inches; ammunition hoists for 24-centimeter guns, 7.87 inches; for 15-centimeter guns, 3.15 inches.

Motive power.—Engines: Three 4-cylinder vertical triple-expansion in separate water-tight compartments.

Boilers: Eight cylindrical and six water-tube (Dürr) boilers, the former in the after and middle boiler-rooms, the latter in the forward boiler-room. Two-thirds of the total H.P. (13,000) furnished by the cylindrical boilers. Each boiler is heated by four furnaces.

Screws: Three.

Coal.—Capacity at load water line, 1,000 tons.

Cost of construction.

	Marks.
Ship and engines	13,500,000
Gun armament	3,000,000
Torpedo armament	780,000
Total	17,280,000

The overhanging stern affords great protection for the balance rudder, the steam steering engines for which are located below the protective deck. The electric-motor installation on board is quite extensive. The endeavor has been to restrict the steam piping as much as possible. The quarters for the admiral's staff, as well as for the 568 men forming the crew, are high and airy and afford comparative comfort.

ARMAMENT.

The arrangement of the armament admits of very efficient all-around fire. The four 24-centimeter guns of 40 calibers length in revolving turrets have an angle of fire of 270 degrees. The two forward turret guns have 10 meters freeboard, and can therefore be used even in heavy sea; the after turret guns have 7 meters freeboard. The medium artillery consists of twelve 15-centimeter R. F. guns of 40 calibers length, one half in armored revolving turrets and the other half in separate armored casemates. The light artillery consists of ten 8.8-centimeter R. F. guns of 30 calibers length, ten 3.7-centimeter machine guns, and four 8-millimeter automatic guns. The whole artillery is arranged in five tiers. Their total efficiency is shown in the following table:

	Large guns (24 cm.).	R. F. guns (15 cm.).	R. F. guns (8.8 cm.).	Machine guns (3.7 cm.).
Head fire	Two	Eight	Four	Four.
Bow fire	Four	Six	Four	Four.
Beam fire	Four	Six	Five	Five.
Quarter fire	Four	Six	Four	Five.
Stern fire	Two	Six	Four	Four.

The same as the new battleships, the *Fürst Bismarck* has two military masts, the forward one being very large, and accessible by winding stairs. In each top are two 3.7-centimeter guns. Each mast also has a search light. Four more search lights are installed on platforms at the height of the battery deck, and can be pushed out and drawn in. This arrangement of search lights is new and offers the advantage of being more effective in guarding against torpedo-boat attacks at night. Moreover, the horizontal cones of rays would have such a blinding effect on the crew of an approaching torpedo boat that this circumstance alone affords a defense. As weapons of offense, there are further provided 6 torpedo-launching tubes for 45-centimeter torpedoes. All of these, with the exception of the stern tube, are submerged and under the protection of the armor, so that they are safe from hostile fire.

PROTECTION.

The building material is best German steel. In view of the contemplated mission of the ship as the flagship of the cruiser fleet in transoceanic waters, she has received a double planking of teak wood, with copper sheathing, beginning at the water line. The armor protection is characteristic of the new ship. It consists, in the first place, of a 200-millimeter armor belt 2.5 meters high, extending entirely around the ship, its thickness decreasing to 100 millimeters forward and aft. The armor material is hardened steel of superior quality. The revolving turrets for the 24-centimeter guns have a 200-millimeter armor; the conning towers, respectively, 200 and 100 millimeters; the revolving turrets and casemates for the 15-centimeter R. F. guns, 100 millimeters. The ammunition hoists and funnel casings are also armored. The parts lying below the water line are protected by a vaulted armored deck 50 millimeters thick. Another protective deck of the same thickness near the citadel rests on the upper edge of the armor belt, and a 20-millimeter splinter deck affords protection against light fragments.

The division into water-tight compartments has been carried to as great an extent as is compatible with the maintenance of the ship's service. Each transverse bulkhead, unpierced by any doors, has been continued up to the water line. In order to go from one engine or boiler room into another, one has to pass across the armor deck below the water line. The difficulty of ventilating the ship in view of this construction has been solved by electrically operated ventilators. Speaking tubes and telegraphs serve as means of communication.

Ammunition shafts and hoists.—The ammunition shafts for the 24-centimeter turrets are rectangular and built of 200-millimeter armor plates. The dimensions of the forward shaft are 1.4 by 1.2 meters; of the after shaft, 1.4 by 1.6 meters. The shafts are prolonged above the floor of the turrets by water-tight glacis 10 millimeters thick and 1.4 meters high. The hoists are run by hydraulic power.

The ammunition shafts for the revolving turrets of the 15-centimeter R. F. guns are circular, 680 millimeters in diameter, and those for the 15-centimeter double casemates elliptic, 680 by 1,540 millimeters; thickness of armor, 80 millimeters. The hoists are run by electricity.

There are six shafts for the 8.8-centimeter guns and four for the 37-millimeter guns. The ammunition is hoisted by Paternoster works, adapted to be run both by hand and electricity. For the guns in the foretop the ammunition is raised through the mast. The ammunition for the maintop guns is hoisted by means of cranes. These are run by hand alone.

MOTIVE POWER.

The engine installation consists of three 4-cylinder vertical triple-expansion engines, which, the same as the boilers, are in entirely separate water-tight compartments. The engines, actuating each a bronze screw, are designed to give the ship, when completely equipped, a maximum speed of 19 knots, which is attained by a total engine efficiency of 13,500 I. H. P. The triple-screw system has been generally adopted in the German navy, after the good results achieved by the first triple-screw ship—the *Kaiserin Augusta*. Its advantages of economy and greater safety make it preferable to the twin-screw system. The same uniformity prevails in the introduction of water-tube boilers, which are to be found in new German constructions, and which have also been adopted in part, if not exclusively, for the *Fürst Bismarck*. The original design was for two-thirds of the boilers to be cylindrical and one-third to be water-tube boilers (Dürr system), but from later information it would seem that water-tube boilers are to be used exclusively. Which system of water-tube boilers the German naval administration will permanently adopt depends upon the trial trips of the cruisers now under construction, all of which have water-tube boilers. Four different systems are being used at the present time, namely: Thornycroft boilers for the first-class battleship *Ægir;* Niclausse boilers for the second-class cruiser *Freya;* Belleville boilers for the second-class cruiser *Hertha;* Dürr boilers for the second-class cruiser *Victoria Luise.* With the exception of the battleship *Ægir* the German navy has as yet no data or practical tests as to the new boiler systems. The results with the Thornycroft boilers on board the *Ægir* were very satisfactory, however, and equally good results are expected of the other systems to be tested. In any event, it is generally acknowledged that water-tube boilers will in future be indispensable for war ships. It is true that they have the disadvantage of greater coal consumption, but on the other hand there is a considerable saving of weight, which in the four new second-class cruisers of 9,000 horsepower, for instance, amounts to about 280 tons. The coal capacity of the armored cruiser *Fürst Bismarck* is 1,000 tons.

The two types of ships—battleships and armored cruisers—are approaching each other more and more and gradually merging their qualities. The characteristic differences are now confined to the armor protection and the radius of action, for the coal capacity of armored cruisers can be increased at the cost of decreasing the weight of armor, while the armament hardly shows any essential difference at the present time. A comparison of the armament of the latest battleship of the German navy (*Kaiser Wilhelm II*) with that of the latest armored cruiser (*Fürst Bismarck*) will plainly illustrate this last statement. Aside from the identical manner of installing the different types of guns, there are on board said battleship and armored cruiser, respectively—

	Kaiser Wilhelm II.	Furst Bismarck.
24 cm. guns in armored turrets	4	4
15 cm. R. F. guns, in separate armored casemates	12	6
15 cm. R. F. guns, in armored revolving turrets	6	6
8.8 cm. R. F. guns, with shields	12	
8.8 cm. R. F. guns		10
3.7 cm. machine guns	12	10
8 mm. automatic guns	12	4
Total	58	40

From the above it will appear that the only difference is in the rapid-fire armament, the cruiser having six 15 centimeter and two 8.8 centimeter R. F. guns, two 3.7-centimeter machine guns, and eight 8-millimeter automatic guns less than the battleship. The torpedo armament is the same in both ships, namely: One 45-centimeter submerged bow tube, four 45-centimeter submerged broadside tubes, one 45-centimeter above-water stern tube. It may be said of the new armored cruiser that the battleship *Kaiser Wilhelm II* has served as a model, and that this type of cruiser is peculiar to the German navy.

ARMORED CRUISER "A."

NOT SHEATHED AND COPPERED.

Name.	Descriptive and explanatory remarks.	Builders.	Keel laid.
"A"	Armored cruiser (under new German classification called grosser kreuzer, i. e., large cruiser).	Imperial dockyards, Kiel	Dec. 1, 1898.

Material of hull, steel; rig, two military masts; complement, 528 men, exclusive of division staff (43); speed, 20.5 knots; I. H. P., 15,000.

Dimensions.—Length, 393 feet 8 inches; extreme breadth of beam, 64 feet 4 inches; draught, mean, 24 feet; displacement, 8,880 tons.

Cost, 11,000,000 marks.

Armament.—Gun: Four 24-centimeter (9.45-inch) R. F. 40-caliber guns in turrets forward and aft; six 15-centimeter (5.91-inch) R. F. 40-caliber guns in separate armored casemates; four 15-centimeter (5.91-inch) R. F. 40-caliber guns in armored turrets; ten 8.8-centimeter (3.47-inch) R. F. 30-caliber guns; ten 37-millimeter (1.46-inch) machine guns; four 8-millimeter (0.315-inch) automatic guns. Torpedo: One 45-centimeter (17.72-inch) submerged bow tube; two 45-centimeter (17.72-inch) submerged broadside tubes, and one 45-centimeter (17.72-inch) armored above-water stern tube.

Protection.—Hull protection: Armor belt, 3.94 inches thick, extending all around, decreasing forward and aft to 3.15 inches. Armored transverse bulkheads forward and aft, 1.97 inches thick. Cork belt fore and aft of casemates.

Protective deck: Turtle-back protective deck extending from stem to stern, horizontal part 40 millimeters thick, inclined part 50 millimeters below water line. Second protective deck resting on upper edge of belt armor and upper edge of casemates.

Turrets, barbettes, redoubts: Thickness of armor of 24-centimeter gun positions, 150 millimeters; of 15-centimeter gun positions, revolving turrets, 100 to 80 millimeters; of 15-centimeter gun casemates, 100 millimeters; conning towers, forward, 150 millimeters, aft, 12 millimeters, special steel; ammunition hoists, for the 24-centimeter turrets, 100 to 80 millimeters, for the 15 centimeter turrets, 80 millimeters; upper deck over upper casemate, 35 millimeters; battery deck over lower casemate, 30 millimeters; between decks fore and aft of lower casemate, 20 millimeters.

Motive power.—Engines: Three triple-expansion vertical engines, of 13,000 I. H. P., to give a speed of 18 knots.

Boilers: Fourteen Dürr water-tube boilers.

Screws: Three.

Coal.—Capacity at load water line, 950 tons.

The new armored cruiser *A* is on the stocks and, it is expected, will be launched in October, 1899. The protective deck is being put on. This deck is not curved, but inclined. It is laid on in flat sheets of nickel-steel Harveyized armor. This deck extends from 4 feet below the water line and joins horizontal plates amidships at height of the water line, making an inclined deck. This inclined deck is made of two plates, and in some places three plates, bolted and riveted together. The two plates are 20 and 30 millimeters thick, and where they have three plates they are 12, 18, and 20 millimeters thick.

In riveting the plates together and all throughout the ship the heads of the rivets are cut off flush with the surface of the plates. The saving in weight by cutting off the rivet heads amounts to 25 tons in the case of the cruiser *A*.

The deck over the engine-room compartment is double the thickness of the other parts of the protective deck. The frames and beams supporting this armored deck are also double the thickness of those in other parts.

This ship will have a center passageway extending from the bow bulkhead to the water-tight bulkhead abaft the engine room. This center passageway is 2 meters high and 3 meters wide. It passes through the smoke pipes, which are built around it. The only access to the center passage is by the doors in the forward and after bulkheads. This is used for electric conductors, steering gear, crew passage, voice tubes, etc. The passage is covered by a protected deck that is flat overhead. The sides are vertical and meet the lower protective deck at the inboard edge of the inclined plates. The upper deck then goes out to the ship's side nearly horizontal, leaving a triangular space over the lower or proper protective deck. The upper protective deck is made of two thin nickel-steel armor plates bolted together, 20 millimeters thick.

A sand blast was put in operation on some plates of the bottom of the cruiser *A*. All the plates are not to be smoothed off by the sand blast. The effect of polishing the outer skin of the bottom plates is an experiment, and after the ship has been in commission and docked the benefit of having some of the plates smoothed will be demonstrated.

The cruiser *A* is being built by Government labor, and while it is somewhat more expensive than by contract the naval constructors claim that the government work is so much better that their work is just as economical in the end.

2. TORPEDO FLOTILLAS.

ENGLAND.

Twelve torpedo-boat destroyers have been ordered by the Admiralty, and it is a remarkable fact that every firm which tendered has received an order for one, two, or three, according to the amount of work they have on hand and the facilities for rapidly carrying through the new vessels to completion. There was, it is stated, a remarkable agreement as to price, which is fully 10 per cent higher than for previous vessels of the same class. The vessels are of the same type as those now completing of 300 tons, with engines of 6,000 I. H. P., to run 30 knots with 30 tons of coal on board, although capacity will be provided for 80 tons. This will bring the number of English destroyers to well over 100.

The names of these boats and their builders are as follows: *Racehorse*, *Roebuck*, and *Greyhound*, by Messrs. Hawthorn, Leslie & Co., of Newcastle-on-Tyne: *Lively* and *Sprightly*, by Messrs. Laird Bros., of Birkenhead (the only Clyde firm on the list); the *Myrmidon*, *Petrel*, and *Syren*, by Palmer's Shipbuilding Company, of Jarrow-on-Tyne; the *Success*, by Messrs. Doxford & Sons, of Sunderland; the *Falcon* and *Ostrich*, by the Fairfield Shipbuilding Company, of Glasgow; and the *Vixen*, by Messrs. Vickers, Sons & Maxim, of Barrow-in-Furness. Messrs. Thornycroft, of London, will get an order also for two or three vessels in excess of the twelve contemplated in the program of 1898–99 and allotted among the firms named. All these firms have experience in the building of this type of craft.

FRANCE.

The boats laid down in 1899, as shown by the table, amount to 12 torpedo boats, 10 torpedo-boat destroyers, 11 submarine boats. In the last item, that of "submarines," France occupies a position apart, the interest and, it may be said, the faith in the boats of this type extending to the mass of the people, as is evidenced by the proposed construction of the *Français* and *Algérien*, to be paid for by public subscription.

RUSSIA.

BUILDING.

GAGARA, WORON, FILIN, AND SOVA.

Two hundred and forty tons, 27.5 knots, 3,800 H. P.; St. Petersburg.

KIT, SKAT, DELPHIN, AND KASATKA.

Three hundred and fifty tons, 30 knots; Schïchau, Elbing.

SOM.

Three hundred and fifty tons, 30 knots; Laird, Birkenhead.

OSIOTR, KEPHAL, LOSOS, FARCK, AND STERLIAD.

Three hundred and twelve tons, 26 knots; Normand, Havre.

Ten similar to *Osiotr* building at Newsky Yards, St. Petersburg.

Three of 320 tons, 27 knots, 5,700 H. P.; Forges et Chantiers de la Méditerranée.

TORPEDO BOATS.

Ten of 200 tons and 24 knots' speed building at Crichton Abo.

Four of 150 tons building at Crichton Abo.

Ten of 150 tons building at Newsky Works, St. Petersburg.

GERMANY.

TORPEDO BOAT D 10.

Division torpedo boat *D 10*, constructed by Thornycroft, has been at last delivered, after a delay of one year. *D 10* was ordered from an English establishment in order to ascertain by special trials if the English manufacturers really can give to their torpedo-boat destroyers a speed so much in excess of that obtained by the German manufacturers. *D 10* is 211.2 feet long, 19.5 feet broad, draught 5.97 feet forward and 7.54 feet aft. Under these conditions it displaces 355 tons, or 125 tons less than the last division torpedo boat constructed, *D 9*, which is the largest in the German navy. *D 10* has two vertical separate engines. Total horsepower, 5,500. It has three water-tube boilers of the type employed on the *Daring*. Its actual speed is 27.5 knots. Boat has two funnels and a coal capacity of 80 tons. Rudder is controlled by steam, which can be replaced in case of accident by hand gear. Its torpedo armament, which is being constructed at Kiel, consists of a tube forward and two tubes in broadside on pivots on the bridge.

After completion by Thornycroft, *D 10* was taken to Germany in October, 1898, and until the spring of 1899 failed to come up to the requirements. These were that the boat should carry a load equivalent to her war equipment, including 40 tons of coal in her bunkers, and that the trial should be made with German machinists and stokers. Under such requirements the contractors would only guarantee a speed of 27.5 knots.

Before the official trial at Kiel the boat had made (September 26, 1898) a preliminary run over the measured mile of Maplin, attaining a speed of 28.54 knots, carrying a load of 84 tons. However, this trial was made at ebb tide, the boat going with the current.

From the time of her arrival in Germany repeated trials were made, and it was not until the spring of 1899 that *D 10* succeeded in making the required speed, and was accepted by the German Government and assigned as division boat of Division C (First division of second torpedo flotilla). The smokestacks had been considerably lengthened and the screw blades renewed.

In consequence of the unsatisfactory results attained by *D 10*, and the grand success of the torpedo destroyers built by Schichau for China (*Hai Lung*, etc.), the German Government decided to order no more boats from England, but to order from Schichau a number of a new standard type of boats intended for high-sea work.

HIGH-SEA TORPEDO BOATS.

The future composition of the German torpedo-boat divisions will be such as to make them more seaworthy and give them greater fighting efficiency. Heretofore the torpedo-boat division consisted of one large boat, called the division boat, and six small boats. In future it is to consist of six boats of equal size, similar to the division boats, with a displacement of 400 tons. Six of these new high-sea torpedo boats, *S 90* to *S 95*, are at present under construction at Schichau's works at Elbing, and a second division has been ordered at the same works. The boats under construction will be 233.1 feet long and 19.68 wide. They are to have two funnels, a conning bridge, and a tower aft, the forward tower has been dispensed with and a wave-breaker substituted. The high-pressure engines of the new boats are to give them a speed of 35 knots an hour. The artillery armament is to consist of five rapid-fire guns, one submerged and two above-water torpedo launching tubes. They are to receive a 10-millimeter protection above the water line.

Among the numerous innovations are better quarters for the crews, which are to consist of 49 men, including officers. The boats under construction are to be delivered next spring, and to be placed in commission during the summer as the "first high-sea torpedo-boat division."

COST OF THE NEW TORPEDO-BOAT DIVISIONS.

The sum estimated under the fleet law for the construction of a new torpedo-boat division, which in future is to consist of six boats, all of the same dimensions, amounted to 5,900,000 marks, including the cost of trial trips and artillery and torpedo armament. Now that a torpedo-boat division of this type is under construction the cost can be estimated more accurately. The cost of construction of the six boats, including expense of trial trips, will amount to 4,874,000 marks, while the cost of one of the former torpedo-boat divisions, consisting of a *D* boat and eight smaller boats, amounted to 4,348,000 marks. The cost of the artillery armament of the new division will also be somewhat higher, namely, 426,000 marks, instead of 396,000 marks, because the new division requires a larger number of small-caliber rapid-fire guns. On the other hand the torpedo armament of the new division will cost only 600,000 marks, as against 1,112,000 marks for the former divisions. This decrease of 512,000 marks in the cost of the torpedo armament is due to the circumstance that the former nine boats of a division required a larger number of launching tubes than the six boats of one of the new divisions. The total increase in the cost of construction, being 44,000 marks per division, is very small as compared to the enhanced fighting efficiency of the new divisions. The expense of keeping the division in repair will be but little higher than formerly, because only five of the six boats are to form the active division, while the sixth boat will be placed in reserve. The formation of one of the former active divisions required seven boats (including the *D* boat), while two of the smaller boats constituted the reserve.

CHINA.

HAI LUNG, HAI NJU, HAI CHING, AND HAI HOHA.

Destroyers.	Built by.	Begun.	Launched.
Hai Lung	Schichau, at Elbing	1896	1898
Hai Nju	do	1896	Dec. 21, 1897.
Hai Ching	do	1896	1898
Hai Hoha	do	1896	1898

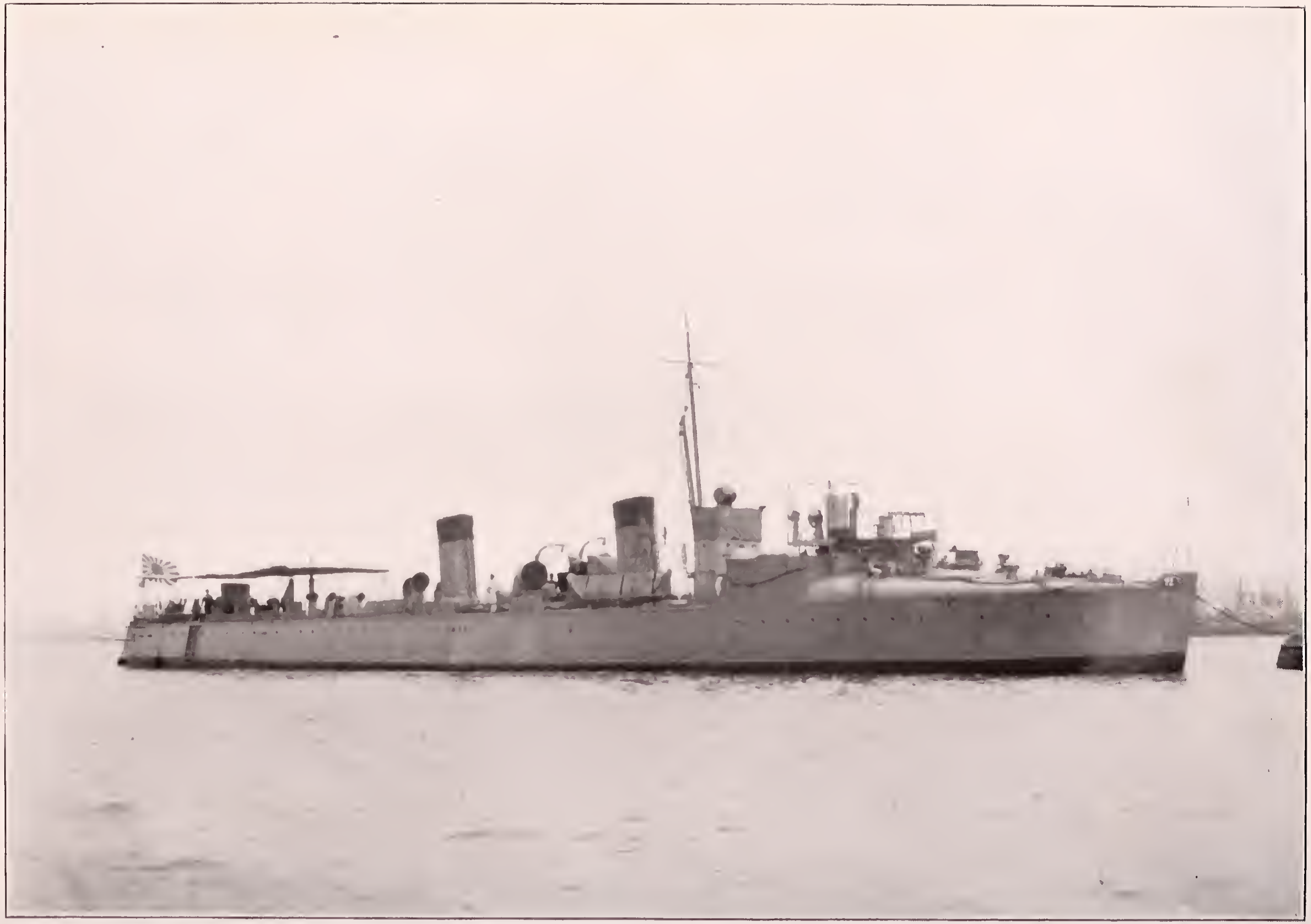
Dimensions.—Length, 193 feet 7 inches; beam, 21 feet; draught, 5 feet; displacement, 280 tons.

Armament.—Six 3-pounder R. F.; 2 torpedo tubes.

Material, nickel steel; number of screws, 2; coal capacity, 67 tons; maximum trial speed, 32 knots; I. H. P., 6,000; boilers, Schichau; engines, triple expansion; funnels, 2.

TRIALS.

The *Hai Lung*, on the run from Pillau to Brüsterort, is reported to have attained a mean speed of 35.2 knots with a load of 25 tons. With a load of 67 tons the boats are said to have attained a speed of between 33 and 34 knots with forced draft, and between 30 and 31 knots with natural draft. These vessels, with their trial load, complete outfit,



SHIRANUI. (Japanese torpedo boat.) 275 tons; I. H. P., 5,800; speed, 30 knots; launched 1899.

and armament, and with 25 tons of coal on board, are reported by Mr. Schichau to have steamed 35.2 knots over the measured course of 18½ sea miles, and with 67 tons of coal (i. e., full bunkers), 33.6 knots. Wind of force five did not materially affect the speed. The course, steered with the compass, was covered in thirty-two minutes thirty seconds, and on one occasion even in thirty-one minutes fifteen seconds. The maximum speed mentioned is 36.7 knots, but it is not stated whether the 35.2 knots, already indicated, is the mean of the runs over the course. All the four torpedo-boat destroyers are said to have made this speed easily, without any effort and without hard work on the part of the stokers. Air pressure 40 to 45 millimeters, equal to 1.58 to 1.77 inches on the water gauge. Contract speed, 32 knots. With natural draft the boats made between 30 and 31 knots with 67 tons of coal on board, and with a large supply of water, to give a radius of action of 5,000 sea miles. With the same load on board and with forced draft the mean speed on a trial of "several hours'" duration was 33.6 knots. Engines and boat behaved well during the trials, notwithstanding the rough weather experienced.

These boats have made the voyage, via Gibraltar, to Port Said, and made the run from Port Said to Colombo, 3,550 miles, without stopping, and on arrival had coal in their bunkers. These boats have a steaming radius of 4,000 miles. After two or three days, the boats continued their journey to North China without requiring the least repair to their boilers and engines.

JAPAN.

MURAKUMO, SHINONOME, YUGIRI, SHIRANUI, KAGERO, AND USUGUMU.

Destroyers.	Built by—	Begun.	Launched.
Murakumo (Darkening Clouds)	Thornycroft, at Chiswick	Jan. 14, 1897	Nov. 17, 1898
Shinonome (Daybreak)	do	do	Feb. 2, 1899
Yugiri (Evening Mist)	do	May 6, 1897	Jan. 26, 1899
Shiranui (Will o' the Wisp)	do	do	Mar. 17, 1899
Kagero	do	May 1, 1898	Aug. 22, 1899
Usugumu	do	do	

Dimensions.—Length, 206 feet 9 inches; beam, 19 feet 6 inches; draught, 5 feet 8 inches; displacement, 279 tons; I. H. P., 5,475; speed, 30 knots.

Armament.—One 12-pounder, five 6-pounders. Torpedo tubes, 2; funnels, 2; signal masts, 2.

MURAKUMO.

The first of 6 torpedo-boat destroyers built for the imperial navy of Japan by Messrs. J. I. Thornycroft & Co., of Chiswick, underwent her official trial trip off the mouth of the Thames on December

5, 1898, making a speed of 30¼ knots in a three hours' run. This vessel is of the same type and dimensions as the 30-knot boats built by the same firm for the British navy. Her mean draught is 5 feet 8 inches. She has twin screws, and is built of special steel of a high tenacity, being about 40 tons. The armament consists of two 18-inch torpedo tubes, five 6-pounder R. F. guns, and one 12-pounder R. F. gun. The latter is mounted in the stern of the vessel instead of on the conning tower, as in the English boats. It is difficult to account for this change, considering that a destroyer is a vessel necessarily of offense, either in carrying out her legitimate functions of destroying torpedo boats, or, if on occasion acting in the capacity of a torpedo boat, in attacking larger vessels. In the former case the fire would certainly be likely to be needed in line of bow. Possibly the Japanese naval officers have some good reason to advance for the change, and one is led to this conclusion from the fact that such alterations as are usually made in vessels for this navy are dictated by a thorough knowledge of the requirements of warfare largely gained during the recent war in the East. Another new feature is a chart house on deck, a most convenient addition. It also serves the purpose of affording an excellent platform for the search light, which is thus enabled to be brought to bear directly ahead of the vessel, a feat not to be accomplished with the arrangement in the British destroyers.

The engines are of the usual balanced type adopted by Messrs. Thornycroft for these craft, having cylinders 20 inches, 29 inches, and two of 30 inches in diameter, with a stroke of 18 inches, running at 400 revolutions per minute, thus giving the very high piston speed of 1,200 feet per minute. The usual auxiliary engines are fitted. These, as is usual in craft of this description, are of the single-cylinder type. Considering the large amount of steam which is needed for driving auxiliaries, one would have thought that it would pay to put in compound engines for these purposes; especially since the plan of exhausting into the low-pressure receiver has been found to have considerable drawbacks. There are three boilers of the Thornycroft water-tube two-furnace or *Daring* type. They have fire boxes of even more than ordinary size, and are fitted with an arrangement of air jets for the purpose of mixing the gases in the furnace and insuring complete combustion. The need for this arises from the fact that the Japanese coal is of a very smoky description. The total heating surface is 11,500 square feet, and the grate surface is 200 feet. The outer casing of one of the uptakes is coupled to the engine room, with the result that the latter is kept very cool during running. It may be stated that the boilers are capable of supplying steam to drive the boat at 22 knots with open hatches. This is an important feature, as it is a great advantage to run with natural draft.

In these boats the crews are berthed at the ends of the vessel, forward and aft, the officers' accommodation being nearer the center of the vessel, aft of the machinery space. This is certainly an improvement as far as the officers are concerned. In other respects the design closely follows the British pattern.

Trial trip, December 5, 1898.—Load carried, 35 tons. Steam pressure had been raised to 210 pounds. Revolutions close on to 400 per minute. Average horsepower, 5,900. Steam pressure, 205 pounds. Vacuum, 24½ inches. Average revolutions, 389 per minute.

There was a stiff breeze from the southwest, which raised a good sea, and on getting into smoother water the speed improved, the average for three hours being 30.48 knots.

Mean speed on the six runs on the measured mile, 30.09 knots. The usual starting, stopping, and manœuvreing trials were successfully carried out before returning.

It is worthy of notice that this vessel commenced her trials a week after launching.

Name.	Date.	Load.	Measured mile.	Continued run (3 hours.)
		Tons.	*Knots.*	*Knots.*
Murakumo	Dec. 5, 1898	35	30.09	30.48
Shinonome	Jan. 6, 1899	35	30.513	30.229
Yugiri	Feb. 14, 1899	35		30.15
Shiranui	Mar. 30, 1899	35	30.443	30.517
Kagero	Sept. 29, 1899	35	30.54	30.24
Usugumo				

IKADSUCHI, INADSUMA, AKEBONO, SAZANAMI, OBORO, AND NIJI.

Destroyers.	Built by—	Begun.	Launched.
Ikadsuchi (Thunder)	Yarrow, at Poplar	Jan. 16, 1897.	Nov. 13, 1898
Inadsuma	do	do	Jan. 28, 1899
Akebono (Dawn)	do	Apr. 30, 1897.	Apr. 27, 1899
Sazanami	do	do	July 8, 1899
Oboro	do	July 1, 1898.	Oct. 5, 1899
Niji	do	do	

Dimensions.—Length, 220 feet 3 inches; beam, 20 feet 6 inches; draught, 5 feet; displacement, 311 tons.

Armament.—One 12-pounder; five 6-pounders. Torpedo tubes, 2; coal capacity, 90 tons; steaming radius, 3,000 nautical miles; complement, ——; speed (estimated), 31 knots; I. H. P., 6,000; funnels, 4; signal masts, 1.

IKADSUCHI.

This is the first of 6 precisely similar vessels under construction by Messrs. Yarrow & Co., Limited, at their yard at Poplar. These boats are interesting in that they are larger than anything hitherto attempted in this direction by Messrs. Yarrow, and that their contract speed is 31 knots.

The engines are triple-expansion and have four cylinders, the two low-pressure cylinders being at each end of the combination, following the Yarrow, Slick, and Tweedie design, and they are so well balanced that the vibration, considering the power produced, is remarkably small. The sizes of the cylinders are: High-pressure, 20½ inches; intermediate, 31½ inches, and two low-pressure cylinders of 34 inches. There are two sets of engines driving twin three-bladed propellers, and the estimated horsepower for the contract speed is about 6,000, though the engines are said to be quite capable of working up to 7,000 horsepower if necessary. The stroke is 18 inches and the number of revolutions about 400 per minute.

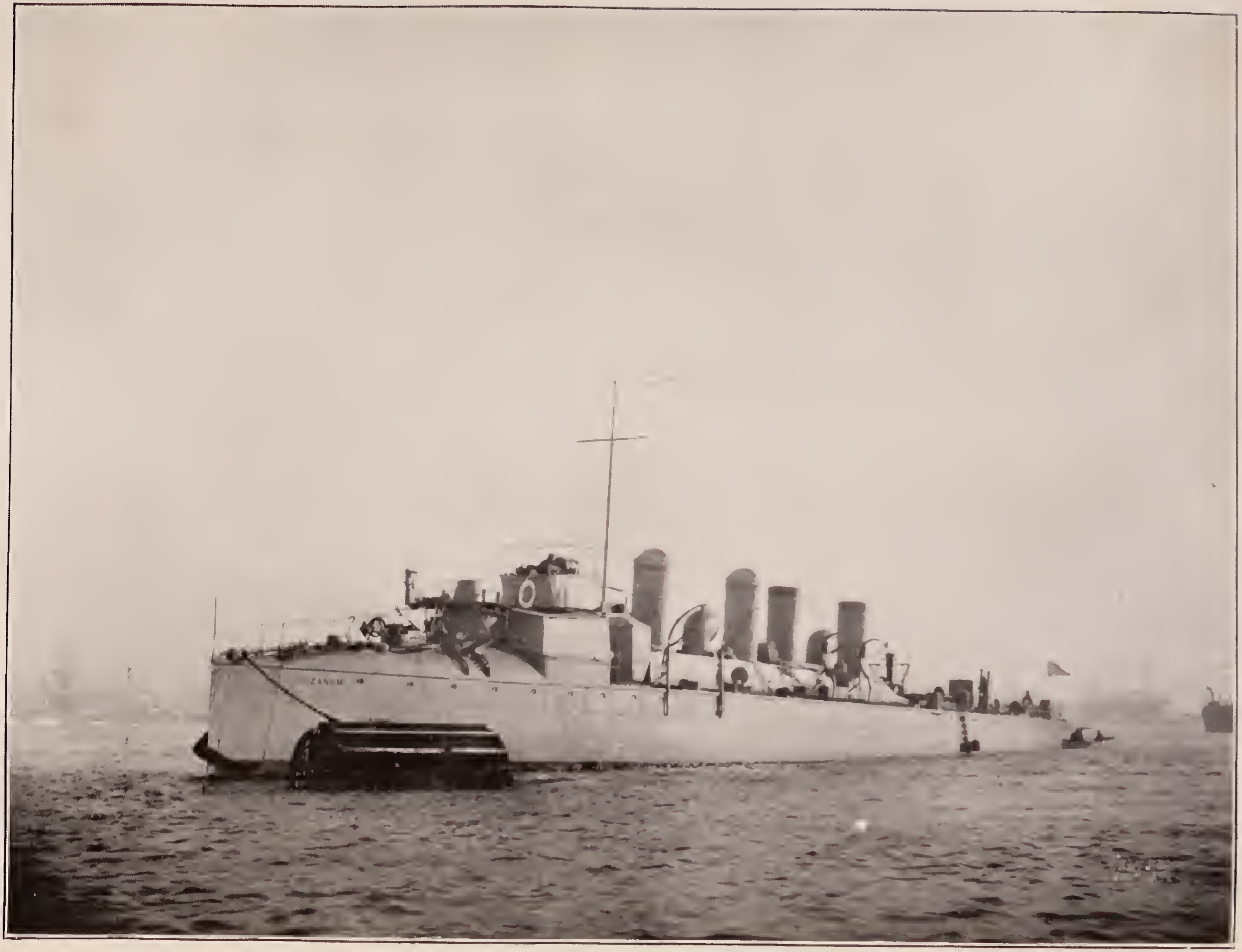
There are four boilers—two for the port and two for the starboard engines. These boilers are of the ordinary Yarrow water-tube type, and are capable, if pressed, of doing well over 1,500 horsepower each. Each boiler has its own funnel. There are two stokeholes, the boilers being placed so that two can be fed from one hole through the three furnace doors with which each is provided. The forced draft is worked by means of a horizontal fan, 6 feet in diameter, the spindle of which descends to the level of the stoking floor, where it is connected to a small horizontal engine. There is, therefore, one fan to two boilers. The boilers are constructed for a working pressure of 250 pounds to the square inch.

The armament consists of a 12-pounder R. F. gun, mounted aft, and a broadside of five 6-pounder R. F. guns. There will be, in addition, two 18-inch torpedo tubes. These will be placed aft, and will be capable of swiveling. There will be storage room for 6 torpedoes. The coal-carrying capacity of these boats is 90 tons, which is capable of taking them at economical speed for a distance of over 3,000 nautical miles. The coal is carried in bunkers situated at the sides of the vessels. The officers' quarters, which are much more roomy than in the generality of destroyers, are in these particular boats placed immediately aft of the engine room, from which they are separated by a bulkhead.

A peculiarity of these vessels is a railway along the deck for loading the torpedo tubes. The convenience of this is great, but it appears liable to be in the way at sea.

SAZANAMI.

Trial July 20, twelve days after launching.—Load carried, 35 tons; duration of trial, three hours; coal burned during the three hours,



SAZANAMI. (Japanese torpedo boat.) 307 tons; I. H. P., 6,000; speed, 31 knots; launched 1899.

15.5 tons. The following figures were obtained in six runs over the measured mile:

	Number of run.						Mean.
	1	2	3	4	5	6	
Boiler:							
Steam ....pounds..	230	230	230	230	230	230	
Vacuum ....inches..	24.75	24.75	24.75	24.75	24.75	24.75	
Air pressure.........do....	0.82	1.06	1.10	1.25	1.20	1.18	1.125
Revolutions	381.4	389.02	390.5	390.6	395.3	390.5	389.6
Time	2 m. 3 s.	1 m. 51 s.	2 m. 2 s.	1 m. 49 s.	2 m. 1.5 s.	1 m. 48 s.	
Speed ....knots..	29.268	32.432	29.508	33.027	29.629	33.333	
Mean speed ....do....	30.850	30.970	31.268	31.328	31.481		
Second mean............do....		30.910	31.119	31.298	31.405		
Mean on miles				31.183.			

Mean revolutions for three hours, 392.09, equivalent to a mean speed during this time of 31.382 knots, and mean air pressure was 1.375 inches.

AKEBONO.

Trial May 5, 1899, nine days after launching.—The speed guaranteed by the contractors for the class on a three hours continuous run, carrying a load of 35 tons, was 31 knots. The details of the trials are as follows: The draught of water forward was 5 feet and aft 8 feet 1 inch, the load carried being 35 tons. Six runs were made over the measured mile on the Maplin, the following being the particulars:

	Number of run.					
	1	2	3	4	5	6
Boiler:						
Steam[1] ....pounds..	226	226	226	226	226	226
Vacuum ....inches..	24½	24½	24½	24½	24½	24½
Air pressure in stokehole....do....	1⅛	1¼	1½	1⅝	1⅝	1½
Mean revolutions per minute..........	432	434½	434½	436½	436¾	439½
Time	1 m. 51 s.	2 m. ½ s.	1 m. 51½ s.	1 m. 59½ s.	1 m. 51¾ s.	1 m. 59 s.
Speed ....knots..	32.432	29.875	32.286	30.125	32.200	30.252
Mean speed....................do....	31.154	31.080	31.206	31.162	31.226	
Second mean speed ....do....		31.117	31.143	31.184	31.194	
				31.159		

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[1] Throttled.

Based on the revolutions necessary to make a knot, the mean speed during the three hours' continuous run was found to be 31.08 knots. The machinery throughout gave no trouble, and there was no flame visible at the funnels at any time. The weather was rather rough and a northeast wind made the sea off the North Foreland lumpy. *This* *vessel was launched nine days prior to the official trial, and had only one preliminary run before the trial took place.*

Name.	Date.	Load.	Measured mile.	Continued run.
		Tons.		
Ikadsuchi	Dec. 15, 1898	35		31.32 (3 hours)
Inadsuma		35		31.037 (3 hours)
Akebono	May 5, 1899	35	31.16	31.08 (3 hours)
Sazanami	July 20, 1899	35	31.18	31.38
Oboro	Oct. 14, 1899	35	31.50	
Niji				

HAYABUSA, KASASAGI, MANADSURA, AND CHIDORI.

Destroyers.	Built by—	Begun—
Hayabusa (Vulture)	Normand at Havre	Apr. 10, 1897.
Kasasagi (Jay)	do	May 10, 1897.
Manadsura (Crane)	do	Do.
Chidori	do	July 6, 1898.

Dimensions.—Length, 147 feet 8 inches; beam, 16 feet 1 inch; draught, 4 feet 9 inches; displacement, 152.39 tons; speed, 29 knots.

Armament.—Three 47-millimeter R. F. guns; 3 torpedo tubes.

SHIRATAKA AND THREE OTHERS.

Built by Schichau at Elbing; begun April 14, 1897.

Dimensions.—Length, 152 feet 7 inches; beam, 16 feet 9 inches; draught, 4 feet 2 inches; displacement, 126.69 tons; I. H. P., 2,600; speed, 28 knots.

Armament.—Three 47-millimeter guns; 3 torpedo tubes.

TORPEDO BOATS NOS. 29 AND 30 AND 3 OTHERS.

Built by Normand at Havre; *No. 29* begun about July, 1897; *No. 30* ordered about January, 1897.

Dimensions.—Length, 121 feet 5 inches; beam, 13 feet 7 inches; draught, 4 feet; displacement, 87.88 tons; speed, 26 knots.

Armament.—One 47-millimeter gun; 3 torpedo tubes.

To be delivered in Japan about July, 1898.

NOS. 31 TO 38, AND 44 TO 49.

Built by Schichau at Elbing; *31, 32, 33, 34, 37,* and *38* already launched.

Dimensions.—Length, 127 feet 11 inches; beam, 15 feet 9 inches; draught, 3 feet 6 inches; displacement, 83.04 tons.

Armament.—One 47-millimeter R. F. gun; 3 torpedo tubes.

I. H. P.——; speed, estimated, 24 knots.

According to report of July 10, 1897, these were to be delivered in Japan in July, 1898, to be sent out on board steamer. Japan Times of May 11, 1899, said that different parts of torpedo boats from England and elsewhere were being put together in various yards in Japan.

NINE FIRST-CLASS TORPEDO BOATS BUILDING BY YARROW AT POPLAR.

Dimensions.—Length, 152 feet; beam, 15 feet 3 inches; draught, mean, 5 feet 2 inches; displacement, 109.73 tons.

Armament.—Two 3-pounder R. F.; one 14-inch bow and two 14-inch swivel-topped torpedo tubes.

These are similar to those lately supplied to the Austro-Hungarian navy and the Chilian Government by Yarrow & Co.—single-screw boats, built of extra strong steel well galvanized, fitted with engines to develop 2,000 I. H. P., and have a speed on trial of 27 knots with the boat carrying a dead load of 20 tons. The propelling engines are three-cylinder, three-cranked, triple-expansion, carefully balanced, supplied with steam by two Yarrow boilers in one stokehold, air pressure which is obtained by a single fan with engine on the stokehold floor. The usual auxiliary engines are fitted in the engine room, a large feed heater being also supplied.

The coal capacity of these first-class sea-going torpedo boats is 30 tons, and ample accommodation for officers and crew is provided. Only one of these boats will be riveted up and tried in England; the others will be sent out packed in pieces for reerection in Japan.

NOS. 50 TO 59.

Torpedo boats building by Japanese Government at Yokosuka and Kure. Begun after January, 1899.

Dimensions.—Length, 111 feet 7 inches; beam, 11 feet 6 inches; depth from top of deck beams to top of keel, 6 feet 7 inches; draught, 2 feet 11 inches; displacement, 52.83 tons.

Armament.—One 47-millimeter Hotchkiss gun; two torpedo tubes.

I. H. P., 657; speed, 20 knots.

The keels of these boats were to be laid in April, 1899; material of hull to be special steel, thickness of plates to vary from 0.1 to 0.14 inch; complement to consist of 2 commissioned and 2 warrant officers and 12 crew. To be provided with one canvas boat. Cost of hull and machinery, $49,000.

The program calls for 6 boats of about 80 tons, to be ordered in 1899 and completed in 1900.

3. VESSELS LAUNCHED IN 1899.

ENGLAND.

Name.	Class.	Tonnage.	Built at—	Begun—	Launched—
Bulwark	Battle ship, first class.	15,000	Devonport	Mar. 20, 1899	Oct. 18.
Glory	do	12,950	Birkenhead	Dec. 1, 1896	Mar. 11.
Implacable	do	15,000	Devonport	Mar. 3, 1898	Do.
London	do	15,000	Portsmouth	Dec. 7, 1898	Sept. 21.
Venerable	do	14,700	Chatham	Jan. 2, 1899	Nov. 2.
Vengeance	do	12,950	Barrow	Aug. 3, 1897	July 25.
Victoria and Albert	Royal yacht	4,700	Pembroke	Dec. 15, 1897	May 9.
Britomart	Gunboat	700	Liverpool	Dec. 1, 1897	Mar. 28.
Pioneer	Cruiser, third class	2,200	Chatham	Dec. 16, 1897	June 28.
Sandpiper	Gunboat	85			Jan. 18.
Thistle	do	700	Glasgow	Sept. 2, 1897	June 22.
Woodlark	do	150	Shanghai		May —.
Woodcock	do	150	do		Do.
Lee	Torpedo-boat destroyer.	283	Poplar		Feb —.
Spiteful	do	322	Newcastle		Jan. 11.
Viper	do	210	Hebburn on Tyne		Sept. 6.

FRANCE.

Name.	Class.	Tonnage.	Built at—	Begun—	Launched—
Jeanne D'Arc	Cruiser	11,270	Toulon	Oct. —, 1896	June 8.
Suffren	Battle ship, first class.	12,278	Brest	Jan. —, 1898	July 25.
Henri IV	Battle ship, second class.	8,948	Cherbourg	July 15, 1897	Aug. 23.
Jurien de la Gravière	Cruiser.	5,685	L'Orient	Nov. 15, 1897	June 26.
Infernet	Cruiser, third class	2,452	Bordeaux		May 7.
Admiral de Gueydon	Armored cruiser	9,517	L'Orient		Sept 20.
Zélée	Gunboat	646	Rochefort		Oct. 18.
Décidée	do	645	L'Orient	Apr. 27, 1897	June 25.
Hallebarde	Torpedo-boat destroyer.	308	Havre	July —, 1896	June 9.
Durandal	do	308	do	do	Feb 11.
230	Torpedo boat	86	Bordeaux		May 7
Morse	Torpedo boat (submarine).	141	Cherbourg	Jan. —, 1898	July 4.
Narval	do	106	do		Oct 20.

RUSSIA.

Name.	Class.	Tonnage.	Built at—	Begun—	Launched—
Gromoboi	Armored cruiser	12,336	St. Petersburg	May 19, 1898	May 20.
Diana	Cruiser	6,630	do	July —, 1896	Oct 12.
Waryag	do	6,630	Philadelphia	May — 1898	Oct 31.
Pallada	do	6,630	St. Petersburg	July —, 1896	Aug. 20.
Yenesei	Transport	2,500	do		May 20.
Delphin	Torpedo-boat destroyer.	350	Elbing		Aug. 14.
Som	do	350	Birkenhead		June 27.

3. Vessels launched in 1899—Continued.

GERMANY.

Name.	Class.	Tonnage.	Built at—.	Begun—	Launched—
Kaiser Wilhelm der Grosse.	Battle ship	11,180	Kiel	Jan. 22, 1898	June 1.
Niobe	Cruiser	2,645	Bremen	Aug. 30, 1898	July 18.
Tiger	Gunboat	896	Danzig	Nov. 8, 1898	Aug. 13.
S-91	Torpedo-boat destroyer.	350	Elbing		Sept. 26.
ITALY.					
Garibaldi	Battle ship	7,398	Sestri-Ponente	Oct. —, 1898	June 29.
Varese	do	7,400	Leghorn	Sept. —, 1898	Aug. 6.
Agordat	Gunboat	1,320	Castellamare di Stabia	Feb. —, 1897	Oct. 12.
Coatit	do	1,320	do	Apr. 6, 1897	Nov. 15.
Lampo	Torpedo-boat destroyer.	320	Schichau		Oct. 8.
Pellicano	Torpedo boat	147	Sestri-Ponente		Apr. 7.
JAPAN.					
Hatsuse	Battle ship, first-class.	15,000	Newcastle	Sept. 24, 1897	June 27.
Asahi	do	15,200	Glasgow	July 5, 1897	Mar. 13.
Yakumo	First-class cruiser.	9,800	Stettin	Sept. 1, 1897	July 8.
Idzumo	Armored cruiser.	9,800	Elswick		Sept. 19.
Miyako	Torpedo-boat destroyer.	1,800	Kure		July 1. Aug. 22.
Kagerou	do	279	Thornycroft	May 1, 1898	
Sazanama	do	300	Yarrow	Apr. 30, 1897	July 8.
Inadzumi	do	311	do	Jan. 16, 1897	Jan. 25.
Yuguri	do	279	Thornycroft		Jan. 26.
Oboro	do	311	Yarrow		Oct. 5.
AUSTRIA.					
Kigyo	Torpedo boat	133	Poplar	July —, 1897	Jan. 25.
Aspern	Torpedo cruiser	2,437	Pola	do	May 3.
Python	Torpedo boat	133	Poplar	do	Feb. 26.
CHINA.					
Kiam Wei	Torpedo-boat destroyer.	850	Fu Chau		Feb. —.
DENMARK.					
Herluf Trolle	Armored cruiser	3,470	Copenhagen		Sept. 2.
BRAZIL.					
Marechal Floriana	Cruiser	3,162			July 6.

3. *Vessels launched in 1899*—Continued.

HOLLAND.

Name.	Class.	Tonnage.	Built at—	Begun—	Launched.
Utrecht	Armored cruiser	4,033	Amsterdam	May 15, 1897	July 15.

PORTUGAL.

Name.	Class.	Tonnage.	Built at—	Begun—	Launched.
Donna Amelia	Cruiser	1,660	Tagus	Aug. 19, 1897	Apr. 10.

ENGLAND.

BATTLESHIPS, FIRST CLASS.

FORMIDABLE, IRRESISTIBLE, IMPLACABLE, LONDON, VENERABLE, AND BULWARK.

(Page 16, No. XVII, Part I.)

	Built at—	Begun.	Launched.
Formidable	Portsmouth	Mar. 30, 1898	Nov. 17, 1898
Irresistible	Chatham	Apr. 11, 1898	Dec. 15, 1898
Implacable	Devonport	July 13, 1898	Mar. —, 1899
London	Portsmouth	Dec. 8, 1898	Sept. 21, 1899
Venerable	Chatham	Jan. 2, 1899	Nov. 2, 1899
Bulwark	Devonport	Dec. 17, 1898	Oct. 18, 1899

Dimensions.—Length, 400 feet; over all, 430 feet; beam, 75 feet; draught, mean, 26 feet 9 inches; displacement, 15,000 tons.

Armament.—Four 12-inch B. L.; twelve 6-inch B. L.; sixteen 12-pounder R. F.; two 12-pounder boat; six 3-pounder R. F.; eight .45-inch Maxim machine; four torpedo tubes, submerged.

Coal capacity, load draught, 900 tons; extreme, 2,000 tons; I. H. P., estimated, natural draft, 15,000; speed, estimated, 18 knots; military masts, two, with one top each; complement, 750. If *Formidable* is used as flagship, she will carry 789 officers and men.

GENERAL DESCRIPTION.

The *Formidable* class may be described as improved *Majestics*. On a less draught they carry a greater store of coal, and though there is no difference in the weight or distribution of armament, many improvements in rapidity of fire are introduced. These six vessels are alike in dimensions, armament, and speed, their only difference being between the three first and the three last as to disposition of armament and in a change from Harveyized to Krupp steel.

ARMAMENT.

Four 12-inch B. L. wire guns of new and improved type, mounted in pairs, two forward and two aft; twelve new Vickers 6-inch R. F. guns mounted in casemates, eight on main deck and four on upper deck (four of these can be fired right forward and four right aft); eight 12-pounder R. F. guns carried on main deck and the other eight on upper deck; three of the 3-pounder guns in each of the military tops. These are Hotchkiss guns mounted on circular railways, for protection against torpedo-boat attacks. There are also eight Maxim guns mounted on the boat deck and superstructure. The two 12-pounder 8-hundredweight R. F. guns for boat and field purposes have an alternative mounting gear arranged so that they may be fired over the forward breastwork. Four submerged torpedo tubes 18 inches in diameter, two forward and two aft, are fitted.

PROTECTION.

The armored protection is arranged on somewhat similar lines to those obtaining on the *Canopus* and her sister ships. The vertical side armor of the *Formidable* is, however, 50 per cent thicker, being 9 inches in substance over a depth of 15 feet and a length of 216 feet, the extent of the armored citadel being further increased by the diagonal armored bulkheads up to a total of 250 feet. The steel armor will all be treated by the improved Harvey process. The power of resisting the penetration of projectiles will therefore be very great in the case of the 9-inch belt. To the vertical armor must be added the thickness diagonally of the armored deck slopes. This would be 4½ inches, giving a total of 13½ inches. The armored bulkheads of the *Formidable*, varying in thickness from 9 inches to 12 inches, are fitted joining the ends of the vertical side armor, thus forming a complete belt around the vital portions of the vessel. There are two protective decks, one being of the now usual turtle-backed shape, on which the armor rests all along the edges, and formed of 2-inch steel plating on the flat portion forward, while on the crown of the turtle back, the slopes of the turtle back, and all the after flat part of the deck toward the stern its thickness is increased to 3 inches. This is an important change. Hitherto the after portion of a battleship's below-deck vitals have been insufficiently covered up. The second armored deck is actually the main deck, and has a protection of 1 inch of steel all over. There is thus practically an armored cofferdam extending throughout the whole of the citadel space.

The four 12-inch guns forward and aft are protected by a stout hood or shield 8 inches in thickness, while the hydraulic mechanism and machinery is protected by a circular armored redoubt or barbette, the thickness of the armor being 12 inches. The 6-inch guns are all inclosed in casemates, having 6-inch shields outside and 2-inch inner walls and doors, all of Harveyized steel. The ammunition is sent up from ammunition passages beneath the lower armored deck through armored tubes leading direct into each casemate. It is therefore under protection from the time that it leaves the magazine.

A conspicuous feature of this ship is the formidable cast-steel ram, in one piece, weighing by itself over 30 tons, and as a protection to the ship while using the ram the sides forward are covered to a great extent with 2-inch nickel-steel plating in addition to the ordinary skin plating of about three-fourths inch in thickness. This would correspond to about 7 inches of ordinary wrought-iron plates, and stiffens the bows of the vessel enormously, independent of the protection which it affords against medium-sized shell fire. The structure of the bows of the *Formidable*, taking armored deck, 2 inches thick, and stiffening plate of similar substance, skin and nickel-steel armor plates, framing, bulkheads, and breastworks into consideration, appears well designed to prevent any serious injury arising from the use of the ram.

LONDON, VENERABLE, AND BULWARK.

The feature of these vessels is a drastic alteration in the disposition of armor. The forward transverse bulkhead is to be done away with and the belt is to be carried forward around the stem.

Instead of a short belt 9 inches thick, with 2-inch plates up to the bows, the side armor in these ships will be 9 inches thick amidships, and taper gradually to 3 inches at the bows; the gradations being 9, 7, 5, and 3 inches. As the armor is placed over the ship's plates, the belt will be nowhere less than 4 inches in thickness. Internally the arrangements as to protective decks will be the same.

The three *Londons* will carry Krupp hardened steel armor.

MOTIVE POWER.

The engines will be of the triple-expansion type, with only three cylinders, as in the case of all recent British battleships, though cruisers are usually provided with four. The cylinders will be 31½ inches in the case of the high pressure, 51½ inches in that of the intermediate, and 84 inches in that of the low pressure, and in each the stroke will be 51 inches. There will be the usual two sets, each driving its separate screw, and the collective power will be 15,000 indicated horsepower, with the engines making 108 revolutions, which is equal to a piston speed of 918 feet per minute, the same as in the *Canopus* class, where, however, the power is less—13,500 I. H. P. Steam is to be supplied from 20 independent water-tube boilers of the Belleville type, with economisers, which are designed with 37,000 square feet of heating surface and 1,168 square feet of grate area. This gives rather less than 2½ square feet of heating surface per indicated horsepower, while 13 I. H. P. is expected per square foot of grate area. Steam in boilers at 300 pounds pressure, reduced at the engines to 250 pounds pressure.

The amount of coal carried at the normal draught is 900 tons, although provision is made for the storage of 2,100 tons altogether. It is calculated that the extra 1,200 tons would bring the ship down 1 foot 8 inches, at the rate of 60 tons per inch.

A special feature of this ship is that the lower bunkers can be coaled direct, independently of the upper bunkers.

NOTES.

Two steel masts, each furnished with one military or fighting top and a searchlight platform; on the main topmast a long-distance semaphore for signaling at sea will also be employed. This semaphore will be about 160 feet above the level of the water line. The masts are provided with three derricks, two forward and one on the mainmast. These derricks, primarily fitted for hoisting out the boats, will be of great utility when coaling.

The boats include four steamboats, two 56 feet in length, and two 40 feet in length, and fourteen sailing and pulling boats, ranging from a 42-foot sailing launch to a small dingey. The two larger boats are capable of steaming about 13.5 knots per hour, and are fitted with torpedo-dropping apparatus. They will also act as scouts while the parent ship is in harbor.

Three independent sets of dynamos and engines are required to light the ship and work the electric-motor fans and the searchlights. Every compartment, except the double bottom, etc., will be efficiently lighted by incandescent lamps. Colomb's lights are fitted for use when the dynamos are not running.

Ventilation will be secured by the use of motor fans outside the boiler and engine room spaces, and by steam fans in these rooms. This plan secures a much cooler temperature in the outside spaces. There will be also a complete installation of electric bells and voice pipes communicating with "exchanges" on all decks. In addition to these, loud-speaking telephones will be fitted at important positions.

The quantity of ammunition which will be maintained in the magazines on board, independently of that for saluting purposes and machine guns, will be no less than 13,000 rounds, which would enable the ship to sustain consecutive actions, under ordinary rapidity of fire, for about four hours. This time, however, might be considerably extended.

CONDOR CLASS.

(Page 18, No. XVII, Part I.)

Name.	Descriptive and explanatory remarks.
Condor class	War sloops of "improved Alert" type, with light draught for river duty.

	Builders.	Keel laid.	Date of launch.
Condor	Sheerness	Jan. 1, 1898	Dec. 17, 1898
Rosario	do	do	Do.
Vestal	do	———, 1899	
Shearwater	do	———, 1899	
Mutine	Laird Bros., Birkenhead	Nov. 2, 1898	
Rinaldo	do	Nov. 8, 1898	

Material of hull, steel, wood sheathed with copper; rig, fore and main masts with square yards, and platforms for machine guns, 20 feet from the deck; weight of hull, 515 tons.

Dimensions.—Length, 180 feet; extreme breadth of beam, 33 feet; draught, mean, 11 feet 6 inches; aft, 13 feet; displacement, 980 tons.

Cost (total, equipped for sea), £65,000 ($316,225).

Armament.—Six 4-inch R. F.; four 3-pounder R. F. Hotchkiss; two Maxim machine guns; torpedoes, none.

Protection.—Hull protection, steel plating, one-fourth inch thick, sheathed with wood 4 inches thick to a height of 2 feet above the load draught. The copper sheathing extends to a foot above the load line. Holds minutely divided into water-tight compartments.

Protective deck: Above the boiler and engine rooms runs a steel water-tight deck, which forms a division between the upper and lower coal bunkers.

Motive power.—Engines: Triple-expansion type, capable of indicating 1,100 horsepower with natural draft, giving a speed of 12.6 knots per hour, and 1,400 horsepower with forced draft, giving a speed of 13.25 knots per hour.

Boilers: Water-tube.

Screws: Two.

Coal.—Capacity at load water line, 130 tons.

BRAMBLE, BRITOMART, DWARF, AND THISTLE.

(Page 18, No. XVII, Part I.)

Name.	Descriptive and explanatory remarks.
Bramble Britomart Dwarf Thistle	Gunboats, first class, for service in shallow waters in hot climates; speed sacrificed to efficiency in fighting equipment.

	Builders.	Keel laid.	Date of launch.
Bramble	Potter, Liverpool	Dec. 1, 1897	Nov. 26, 1898
Britomart	do	do	Mar. 28, 1899
Dwarf	London & Glasgow Co., Glasgow	Dec. 2, 1897	
Thistle	do	do	June 28, 1898

Material of hull, steel; wood, copper-sheathed; funnels, one; rig, two masts with one military top on each; complement, 70, officers and crew; number of boats carried, four on shelter deck, one a steam cutter.

Dimensions.—Length, 180 feet; over all, 187 feet 6 inches; extreme breadth of beam, 33 feet; draught, 8 feet, when loaded; displacement, 700 tons.

Armament.—Two 4-inch R. F.—one on forecastle and one on main deck aft; four 12-pounder R. F.—one on each bow under forecastle, and one on each side amidships; ten Maxim .45-inch—six on the broadside and four in the portable military masts. Torpedoes: None.

Protection.—Hull protection: Steering and chart houses and bulwarks all fore and aft, built of bullet-proof steel, tested to withstand bullets from the Lee-Metford rifle within a range of 10 feet. Machinery protected its whole length by longitudinal coal bunker about 6 feet wide, the inner bulkhead of which is water-tight, while the bunker is further subdivided into three water-tight compartments by transverse bulkheads, all having sliding water-tight doors, worked from the upper deck. Upper and lower decks completely plated over with steel and made water-tight, and all openings have water-tight covers, the upper being sheathed with teak and the lower with Danzig deals.

Protective deck: None.

Motive power.—Engines: Two sets of triple-expansion three-crank engines; diameters of cylinders—high pressure 11 inches, mean pressure 17 inches, low pressure 27 inches; stroke 16 inches. Air pump, 11 inches in diameter, 6 inches stroke, worked by levers on high-pressure engine. Condenser of sheet brass; cooling surface of both condensers, 1,510 square feet.

Boilers: Two Yarrow water-tube. Heating surface, 4,000 square feet; grate surface, 80 square feet. Wood fuel. Working pressure, 250 pounds—215 pounds at engines.

Auxiliary machinery consists of an electric-light installation, Siemens dynamos, and Belliss engines; distilling plant (Kirkaldy); ice-making apparatus (Haslam, Derby); feed, fire, and bilge engines (Weir).

Screws: Two.

Coal.—Capacity at load-water line, 50 tons.

The space below the lower deck is wholly occupied by the magazines, shell rooms, gunners' stores, electric stores, commander's and warrant officers' stores, etc., each space being a separate water-tight compartment. Between the lower and upper deck, abaft of the machinery, the commander's and officers' quarters are placed, and, considering the size of the vessel, the quarters are very comfortable. Forward of the machinery the crew and petty officers are berthed in large, airy apartments. Owing to the fact that these vessels are to be employed mostly in hot climates, everything has been done to insure a good supply of fresh air by means of skylights, fans, wind sails, ventilators, etc., and in the way of all the quarters the wood sheathing on the outside of the ship has been carried right up to the upper deck to further protect the officers and men from the heat of the sun striking on the bare plating. There is also an ice-making machine fitted on board to provide ice, which will prove very beneficial in cases of fever, etc., as well as for preserving fresh food. The forecastle deck extends for about 50 feet from the stem, and in continuation of the same a shelter deck extends to beyond the after end of the machinery space. This deck is made up of two thicknesses of teak with felt between, and is open at the sides, being supported from the deck below and bulwarks by bulb angle frames; this, with an arrangement of double awnings, will provide ample protection for the men when in the tropics. The forward and after peaks are fitted as trimming tanks, which will enable the vessel to get more easily over the bars or banks in the rivers. These tanks can be filled direct from the sea, and are emptied by the steam pumps in the engine room.

The vessel is provided with a steam-steering engine placed in the engine room, and controlled from the chart house and flying bridge; and besides this there is a powerful hand-steering gear in the wheel house abaft the engine casing.

The sterns of these vessels present rather a novel appearance. They carry their breadth of deck well aft, and the lower part of the hull has been arched out on each side in the wake of the propellers, thus giving as much deck space on the lower deck as on the upper. The stem, stern frame, rudder, propeller brackets, and boss brackets are all of phosphor-bronze; in fact, the fittings are similar to those for the larger cruisers, the only difference being that the spaces are smaller.

The centrifugal pump drives an auxiliary air pump, and a stop valve is fitted on the condenser to shut off the exhaust pipe from the low-pressure cylinder, so that the condenser may be used for the auxiliary engines when the main engines are not working The engines and boilers are of the express type for a moderate power. Cockburn's reducing valves are used throughout, and Thornycroft's feed regulators are fitted to each boiler.

WOODLARK AND WOODCOCK.

Name.	Descriptive and explanatory remarks.	Builders.
Woodlark Woodcock	Shallow draught screw steamers for river service. Made in England, taken out to Shanghai on board ship, put together there, and commissioned May 16, 1899, exactly twenty-eight days after arrival. (May 16 and twenty-eight days refer to Woodlark only.)	Thornycroft yard, Thames.

Material of hull, steel; number of funnels, one; rig, one pole mast; complement, 25 all told.

Dimensions.—Length, 145 feet; extreme breadth of beam, 24 feet; draught, 2 feet; displacement, 150 tons; speed, 13.396 knots.

Armament.—Two 6-pounder R. F. Hotchkiss guns, all-round fire, one forward, one aft, on upper deck; two .45-caliber Maxim guns on each side of upper deck, with shields.

Tactical data.—Woodcock made a complete circle in about 125 yards, or 2.5 times her own length.

Protection.—Hull protection: Sides and machinery protected by Cammell bullet-proof steel plating; deck houses of special Harveyized steel, which will resist a bullet from a Lee-Metford rifle at 25 yards; nine watertight bulkheads.

Protective deck: None.

Motive power.—Engines: Twin-screw, compound; cylinders 12 inches and 19.75 inches in diameter, with stroke of 11 inches. I. H. P., 560.

Boilers: Two of Thornycroft's patent "speedy" type, working at a pressure of 130 pounds.

Screws: Thornycroft's patent turbine propellers, two on each shaft, making four in all; two driving her when going ahead and two when going astern.[1]

Trials.—*Woodcock:* Revolutions, 300; steam, 135 pounds; vacuum, 26.25 inches; low-pressure receiver pressure, 38 pounds; air pressure in stokehole equal to 1.25 inches of water; vessel's draught was 2 feet forward and 1 foot 6 inches aft; mean, 1 foot 9 inches. Thus down by the head, and holds a terrible quantity of wind, but made 12.6 knots, speed on trial at home in best trim and with no wind having been 13.6 knots. (This trial held in the Yangste, China.) Very little vibration at full speed, and though there was quite enough sea to thoroughly test her, not a joint or a rivet showed a sign of leaking, everything working perfectly.

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[1] These propellers are half out of water when the steamer is at rest, but each pair works in a sort of large tunnel, and is covered with water when vessel is under way. There are two rudders coupled, and as it has been found that these vessels steer very indifferently when going astern, the *Woodcock* is fitted with a leeboard on each side forward. She will be steered with a wheel on the fore part of the upper deck. The propellers being covered in are protected from injury or damage, and they have this advantage over stern wheels.

Woodlark (on Thames): Mean draught, 1 foot, 11.5 inches; speed, 30.75 miles in two hours. (Contract speed was to be 15 miles per hour; draught not to exceed 2 feet when loaded with 30 tons dead weight.) Speed astern, 4.75 miles per hour, and she proved to be under control going astern.

HERON CLASS.

Light-draught river steamers.

	Builders.	Keel laid.
Heron	Yarrow & Co., Isle of Dogs	1896
Jackdaw	do	1896
Sandpiper	do	1896
Nightingale	do	1896
Robin	do	1896
Snipe	do	1896

Material of hull, steel, galvanized; number of funnels, one; rig, one pole mast.

Dimensions.—Length, 100 feet; extreme breadth of beam, 20 feet; draught, mean, 20 inches; displacement, 85 tons.

Armament.—Gun: two 6-pounder, R. F.; four .45-inch Maxims; Torpedo, none.

Motive power.—Engines: Two sets of triple-expansion surface-condensing engines.

Boilers: Yarrow water-tube type, arranged to work under forced draft in a closed stokehole, for which purpose there is a fan and engine on the plan of a torpedo boat. The boiler is designed for the use of wood fuel.

Screws: Two, in raised tunnels.

The *Heron* is the first of six vessels ordered by the British Admiralty from Messrs. Yarrow & Co. in the latter end of 1896. They are constructed in eight floatable sections, and the hull is cut transversely into eight parts of comparatively small size, bulkheads being provided at the ends of each such part, which can be lowered from the deck of the transporting steamer into the water alongside and then bolted together, thus forming an entire hull of the gunboat. The whole of the boat proper is constructed of galvanized steel, which galvanizing adds greatly to the life of the vessel. The draught of water in a fully equipped and laden condition is only 2 feet, which makes these vessels most useful for ascending shallow rivers, as their speed is fairly good, viz, about 10.5 miles per hour.

On the main deck of the vessel there are cabins for officers and warrant officers, and on these is a second or battery deck, on which are rapid-firing guns and rifle caliber automatic guns. These, as well as the cabins, are protected from rifle bullets by bulwarks and shields of very hard and strong steel, which is perfectly rifle-shot proof. The steering wheel is on the forward part of the upper deck inside a bullet-proof conning tower. The vessel can be steered either by steam steering gear or by hand, and there are three rudders, to secure great manœuvring power, which, of course, is necessary in navigating tortuous rivers. The officers have their quarters in the forward end of the vessel on the main deck, and the crew sleep under canvas on the battery deck. The holds under the main deck contain the magazines and provisions.

The propelling machinery consists of twin screws, working in tunnels in the after part of the hull, actuated by two sets of triple-expansion surface condensing engines. The boiler is of the Yarrow water-tube type, arranged to work under forced draft in a closed stoke hold, for which purpose there is a fan and engine on the plan of a torpedo boat. The boiler is designed for the use of wood fuel. There is a centrifugal circulating pump and engine, also an evaporator for making fresh water for drinking purposes as well as for the supply of the boilers.

The speed, fully armed and provisioned, is 10.5 miles per hour.

The *Heron* arrangement of propellers is as follows: As the propellers must not project below the bottom of the boat, the draught of water (being limited to 2 feet) would not admit of a larger propeller being used than about 2 feet diameter, with the usual arrangement of the stern. In order, however, to propel so large and beamy a vessel at 10 to 11 miles per hour it requires two screws of at least 3 feet 5 inches diameter, which would be uncovered with water for a large part of their diameter unless the following device were adopted: The propellers work within two channels raised up in the bottom of the boat, the upper part of these being well above water. As soon as the propellers begin to revolve they rapidly expel the air from the upper part of the tunnels, or inverted diving bells, and then they work in solid water, enabling them to drive the vessel efficiently, although not with equal efficiency to what it would be if the draught had admitted of the ordinary screw. On the highest part of each tunnel there is an air-tight door, which is consequently always above the surrounding water, and through which access is obtained to the propellers for renewals or clearing away weeds. A propeller can be removed and replaced by another within ten minutes.

Projecting from the stem of the boat is a long, hollow steel pole, from which a steel lever hangs down to any desired depth below water. Should the vessel get into shallow water and be in danger of running aground, the lever touches first and, by means of a cord, rings an alarm bell in the pilot house, thus giving timely warning to the pilot to stop the engines. This draught indicator is usually set to touch the ground at a draught of 12 or 18 inches greater than the draught of the steamer.

Another provision is made by means of two steel poles with mushroom heads and two special winches for pushing off or lifting the fore end of the boat from a bank, should she, notwithstanding the first-named warning device, get aground.

The crew are berthed on the battery deck under canvas, well above the river level, which is important in hot and unhealthy locations. The canvas roof is supported by a strong, wooden framework, from which the hammocks are slung and every convenience is provided in the shape of lockers, mess tables, small-arm racks, etc., and the upper deck is thus converted into a cool, roomy mess room.

Two of these gunboats are on the Niger, having been put together at the mouth of that river, and in actual work this system of propulsion is giving the best possible results, the propellers being completely incased and well protected from damage.

The *Heron* and *Jackdaw*, together with their propelling machinery, etc., were completed at Poplar—they being built in sections—and subsequently delivered in Chatham dockyard. Here the sections of their hulls, machinery, guns, ammunition, provisions, etc., were stowed in the hold of a vessel named the *Frutera*, which shortly afterwards left Chatham for Forcados, at the mouth of the Niger. Arrived there, the *Frutera* proceeded some 50 miles up the river to Warri, where the work of putting the gunboats together was effected. Some 60 men of all grades were engaged in their reconstruction, 30 of them being Kroomen.

The vessels had to be put together in a 5-knot current, but all hands worked together with a will from the commencement, the first day being occupied in getting out provisions and ammunition. In thirty-four working days both vessels were completed, their machinery tried under steam, and guns mounted ready for action.

FRANCE.

GUEYDON.

(Page 10, No. XVII, Part I.)

The armored cruiser *Gueydon* was launched September 20, 1899. She is a steel ship with a slight ram bow, four funnels in line of keel, two forward and two aft; a military mast forward, with two tops, and a signal mast aft. Her complement is to consist of 32 officers and 578 men. Her dimensions are as follows: Length, 452.8 feet; extreme breadth of beam, 63.65 feet; draught, 24.6 feet; displacement, 9,517 tons. Her estimated cost is $4,015,788.25.

The armament will comprise two 19.4-centimeter (7.64-inch) guns in armored turrets; eight 16.4-centimeter (6.46-inch) R. F. guns; six 10-centimeter (3.94-inch) R. F. guns; eighteen 47-millimeter (1.85-inch) R. F. guns; six 37-millimeter (1.46-inch) R. F. guns, and two 65-millimeter (2.56-inch) guns. Two submerged torpedo tubes will also be fitted.

The ship will have six searchlights.

The hull protection will consist of a complete armor belt at the water line 150 millimeters (5.91 inches) in thickness, lighter armor above, 95 millimeters (3.74 inches) thick; the armor belt will be 90 millimeters (3.54 inches) thick forward, and 80 millimeters (3.15 inches) thick aft.

A protective deck 50 millimeters (1.97 inches) thick protects the vital parts of the ship. The turrets for the 19.4-centimeter (7.64-inch) guns are protected by armor of 200 millimeters (7.87 inches) thickness.

Power will be furnished by three vertical triple-expansion engines, developing 19,600 indicated horsepower, and giving a speed of 21 knots, actuating three screws. Steam will be supplied to them by four sets of the simple Normand water-tube boilers and eight sets of the double Normand-Sigaudy type. The coal capacity at the load water line will be 1,020 tons, and the total capacity 1,600 tons. The endurance at maximum speed with the above amounts of coal on board is estimated, respectively, at 1,230 and 1,920 miles; and at 10 knots speed 6,500 and 10,300 miles.

INFERNET.

(See page 169, No. XVI, Part IV.)

The *Infernet*, a third-class steel cruiser, sheathed with wood and coppered, building at Bordeaux, was launched September 7, 1899. She has a slightly ram bow and two funnels. Her crew will consist of 15 officers and 219 men. Her dimensions are: Length, 311.6 feet; beam, 39.37 feet; draught, 17.68 feet, and displacement, 2,452 tons. The estimated cost is $935,122.78.

Her armament is to consist of two 13.86-centimeter (5.45-inch), four 10-centimeter (3.94-inch), eight 47-millimeter (1.85-inch), two 37-millimeter (1.46-inch) rapid-fire guns and one 65-millimeter (2.56-inch) gun.

Protection to the vital parts of the ship is secured by a complete protective deck.

Two vertical triple-expansion engines, with a total of 8,500 I. H. P., will drive twin screws, and the estimated speed is 20.5 knots. Steam is to be provided by water-tube boilers.

With a load water-line capacity of 345 tons of coal and a total capacity of 480 tons, the radius of action expected, respectively, at maximum speed is 1,000 and 1,290 miles, and at 10 knots 5,750 and 8,000 miles.

CHATEAURENAULT.

Armored cruiser, closely resembling *Guichen.* Laid down at La Seyne May 21, 1896; launched May 15, 1898.

Steel hull, not sheathed and coppered; considerable freeboard and sheer forward; slightly rounded ram bow; anchors heave up and stow in hawse pipes; four funnels fore and aft; two pole masts; complement, 600.

Dimensions.—Length, 442 feet 11 inches between perpendiculars, 457 feet 6 inches over all; beam, 55 feet 9 inches; draught, mean, 22 feet 6 inches; aft, 24 feet 4 inches; displacement, 8,018 tons.

Cost, 15,201,628 francs.

Armament.—Two 16.4-centimeter (6.46-inch) R. F. guns, one forward and one aft, protected by shields, and each has separate ammunition hoist; six 13.8-centimeter (5.43-inch) R. F. in sponsons with circular shields around guns, two firing fore and aft; ten 47-millimeter (1.85-inch) R.F. about deck; five 37 millimeter (1.46-inch) R. F.; two torpedo tubes above water aft. Searchlights, six—two on masts and four underneath battery deck, two forward and two aft.

Protection.—No side armor. Sponsons have about 2.75 inches of steel armor protection on ship's sides; bulkheads; cofferdam. Protective deck, horizontal, 2.75 inches thick amidships, 4 inches on slopes over machinery, tapering at bow and stern. Armored conning tower.

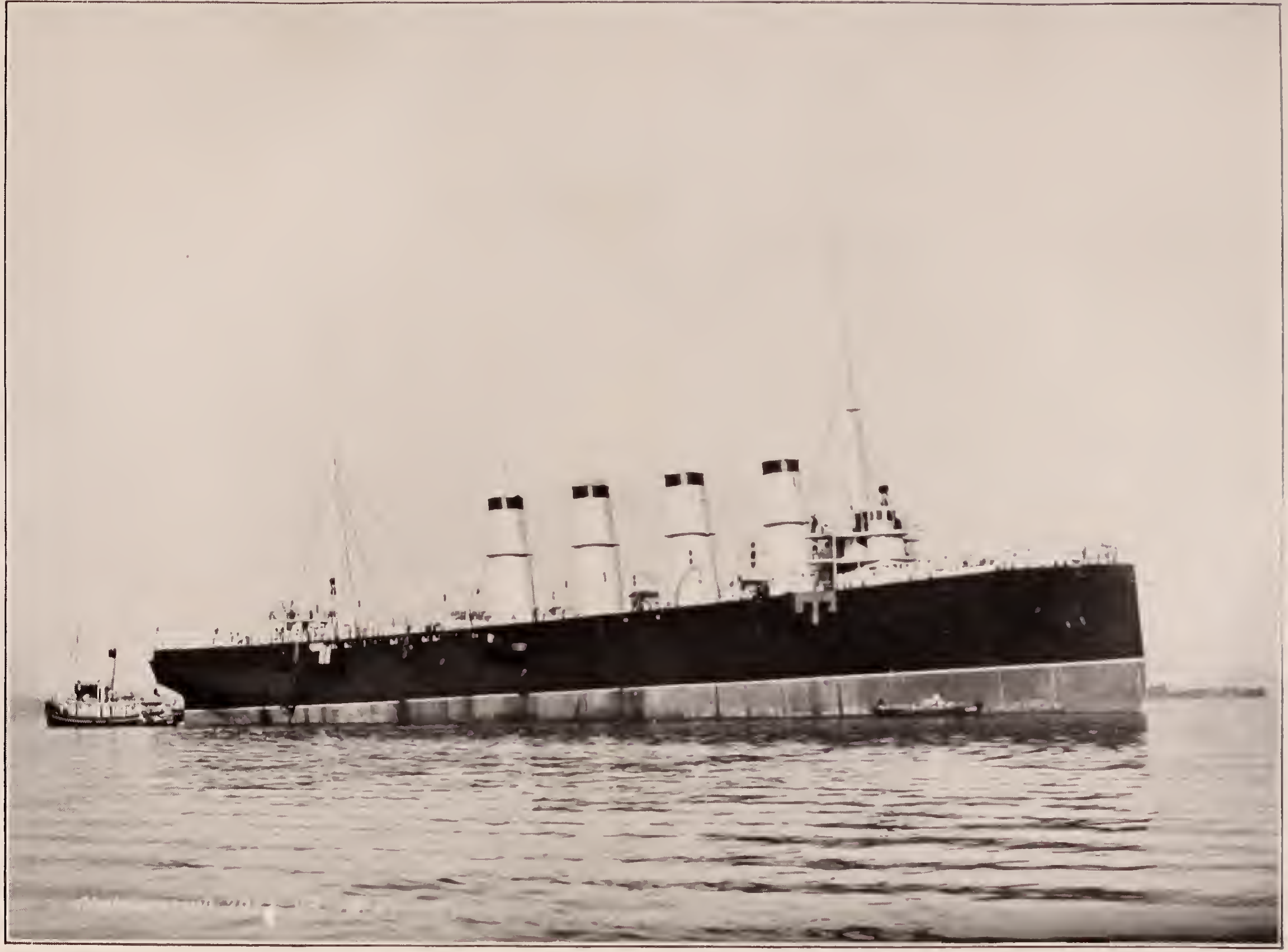
Motive power.—Three sets vertical triple-expansion engines, made by Forges et Chantiers de la Méditerranée at Havre. Central engine room abaft two outer ones. I. H. P. natural draft, 13,800; forced, 23,000; speed, 23 knots; boilers, Normand-Sigaudy double-ended, 14 in number, made by same company as engines; working pressure, 210 pounds; total weight of machinery, 1,680 tons. Screws, 3 four-bladed. Steam steering gear, under protective deck.

Coal capacity.—Normal, 1,400 tons, giving radius of action of 7,500 miles at 12 knots; with full bunkers, 2,100 tons, giving radius of action at 12 knots 10,000 miles.

Carries also petroleum fuel. Sustained natural-draft speed is 21 knots, estimated.

Decks covered with thick linoleum; fittings of metal; iron furniture.

Ammunition hoists.—Special hoist for forecastle and two forward guns in sponsons, one for poop and two after guns in sponsons, and several hoists for rapid-fire guns.



CHATEAURENAULT. (French cruiser.) 8 018 tons; I. H. P., 23 000; speed, 23 knots; launched 1898.

ITALY.

CRUISER GARIBALDI.

(Page 61, No. XIII; 65, No. XV; 19, No. XVI, Part II; 197, No. XVI, Part IV; 26, No. XVII.)

There has been some confusion as to the ships named *Garibaldi* and *Varese*, built in Italy and sold to other Governments. The following is the correct list:

Original name.	Present name and owner.	Built by—
Giuseppe Garibaldi I	Garibaldi (Argentina)	Ansaldo & Co., Sampierdarena.
Giuseppe Garibaldi II	Cristobal Colon (Spain, sunk)	
Giuseppe Garibaldi III	Pueyrredon (Argentina)	
Giuseppe Garibaldi IV	New Italian cruiser	
Varese I	San Martin (Argentina)	Orlando Bros., Leghorn.
Varese II	Gen. Belgrano (Argentina)	
Varese III	New Italian cruiser	

In 1895 the Government placed an order with the firm of Ansaldo & Co. for an armored cruiser named *Garibaldi*, and before she was launched the Argentine Government wished to purchase her. The Italian Government agreed to the sale on the condition that a second ship be built on the same lines and within the period fixed for the delivery of the first. The new vessel was fitted with water-tube boilers, whereby certain advantages were gained; but when this second vessel was completed the Spanish Government was allowed to purchase, and she became the *Cristobal Colon*. A third was laid down, rapidly completed, and again the Argentine Republic coveted her and got her, the ship being named the *Pueyrredon;* and now Messrs. Ansaldo have launched their fourth vessel of the same type. She continues, so far, an Italian ship, and is named the *Garibaldi*.

All these four vessels, it will be seen, have been floated within about four years from the beginning of the first, which is a splendid performance. In the case of the last, the fourth vessel, the keel was laid on September 21, 1898, while the launch took place on June 29 last, about nine months from the laying of the keel. The vessel was not a mere shell, either, for all the shafting was in place and finished up to the engine room. All the auxiliary engines in the engine and boiler rooms were fitted, and where possible their pipes were coupled up to them. All double-bottom pipes and valves and bilge pipes and valves were fitted in place and finished. Incidentally it may be remarked that the adoption of water-tube boilers confers a great advantage, as the decks are no longer required to be left open, because the boilers can be passed down the funnel hatches. The funnel hatches of the *Garibaldi* were thus all finished and the steel decks around them riveted up.

This fourth cruiser is slightly larger than its three predecessors. They were 328 feet long between perpendiculars, 58 feet 8 inches beam, and at 24-feet draught displaced 6,882 tons. The engines, of 13,000 indicated horsepower, gave a speed of between 19.5 and 20 knots. The new vessel now launched is 344 feet long, 61 feet 3 inches beam, and at 23 feet 4 inches draught displaces 7,398 tons. The engines are to give 13,500 indicated horsepower, and extra boiler power has been provided to insure this. Thus the speed will be quite 20 knots. The extra length is accounted for in the two boiler rooms.

The armament slightly differs from that of the three previous vessels. There is only one 10-inch breechloader, but two 8-inch quick-firers, with fourteen 6-inch quick-firers, so that the whole installation is more powerful. The armor belt is of 6-inch nickel steel, as are also the gun casemates, while the protective deck is 1.5 inches thick. The vessel will probably be completed this autumn. Thus instead of building only one ship leisurely, Messrs. Ansaldo, by arrangement with the Government, have been able to build four in about four years, representing a gross turnover of some 2,680,000 lire instead of 680,000 lire.

TORPEDO CRUISER AGORDAT.

(Page 65, No. XV; page 61, No. XIII.)

On Wednesday, October 11, the *Agordat* was successfully launched at Castellammare. The *Agordat* is a fighting ship of the sixth class, a torpedo cruiser of the *Partenope* type, but larger and with specially improved motive apparatus. While the vessels of the *Partenope* type displace from 840 to 940 tons and have 4,000 H. P., the *Agordat* is to have about 1,320 tons displacement and 7,500 H. P. The hull has been constructed in the Italian royal navy-yard at Castellammare di Stabia, from plans made by Engineer Nabor Soliani, and is of graceful shape and warlike appearance. It is easily distinguishable at a distance by its very high bow and two tall funnels. The dimensions of the ship are: Length between perpendiculars, 287.4 feet (87.60 meters); extreme breadth, 30.5 feet (9.30 meters); draught forward, 9.9 feet (3.03 meters); maximum draught, 13.9 feet (4.25 meters). It is built entirely of soft steel. The use of wood has been restricted as much as possible in order to obviate the danger of fires during battle. In the living quarters aluminum has to a great extent been substituted for wood.

The armament is to consist of fourteen 76-millimeter R. F. guns and two machine guns on the conning bridge, besides two torpedo-launching tubes of the regulation type of the Italian royal navy.

The protection consists of a protective deck of face-hardened steel extending over the whole length of the ship.

The motive apparatus has been planned and constructed by the firm of C. & T. T. Pattison, of Naples, as the result of a competition among Italian constructors at the instance of the minister of marine. Said firm has also been intrusted with the mounting of the motive apparatus, which consists of two triple-expansion 4-cylinder engines, each actuating one of the screws, and of eight water-tube boilers of the Blechynden type, having a working pressure of 15 atmospheres. This motive apparatus, though of a light type, is strong and substantial and fully able to develop the power above indicated. It is of the most modern type and has been given special attention by the constructors in order to avoid, under all circumstances, the vibrations which, with ordinary motors, are so injurious to ships.

The motive apparatus is characterized by the absence of auxiliary machinery in connection with it, all of the auxiliary machinery being independent and actuated by its own motors. Of course, there are quite a number of auxiliary engines, such as evaporators for the production of fresh water for the boilers, distillers for the production of drinking water, pumps for the circulation of water in the condensers, main and auxiliary pumps for feeding the boilers, fire pumps and pumps for service on board, dynamos for electric light, and ventilators for ventilation and forced draft.

There is also machinery for manœuvring the helm, weighing anchor, mooring, etc.

JAPAN.

ASAMA AND TOKIWA.

(Page 26, No. XVII, Part I.)

	Built at—	Launched.
Asama	Elswick	Mar. 22, 1898
Tokiwa	do	July 6, 1898

Dimensions.—Length, 408 feet; breadth, 67 feet; draught, mean, 24 feet 4 inches; displacement, 9,700 tons.

Armament.—Four 8-inch R. F. guns; fourteen 6-inch R. F. guns; twelve 12-pounder R. F. guns; seven 2½-pounder R. F. guns. Torpedo tubes, five.

Engines, triple expansion; boilers, cylindrical; coal capacity 600 to 1,300 tons; radius, 5,000 to 10,000 miles; speed, 21½ knots.

IDSUMO AND IWATE.

	Built at—	Status.	Launched.
Idsumo	Elswick	Building	Sept. 19, 1899
Iwate	do	do	

Dimensions.—Length, 400 feet; breadth, 68 feet 6 inches; draught, 24 feet 3 inches; displacement, 9,800 tons.

Armament.—Four 8-inch R. F.; twelve 6-inch R. F.; smaller R. F. and machine guns. Torpedo tubes, four submerged.

Engines, triple expansion; boilers, Belleville; coal capacity, 1,300 tons; radius, 10,000 miles; speed, 21 knots.

YAKUMO AND ADSUMA.

	Built at—	Status.	Launched.
Yakumo	Stettin	Building	July 8, 1899
Adsuma	Rochefort	do	

Dimensions.

	Yakumo.	Adsuma.
Length	407 feet 9 inches.	445 feet 10 inches.
Breadth	64 feet 4 inches.	59 feet 6 inches.
Draught	23 feet 9 inches.	28 feet, maximum.
Displacement	9,436 tons (about)	9,436 tons.

Armament.—Four 8-inch R. F.; twelve 6-inch R. F.; twelve 3-pounder R. F.; twelve 1-pounder R. F. and machine. Torpedo tubes, 5, four submerged.

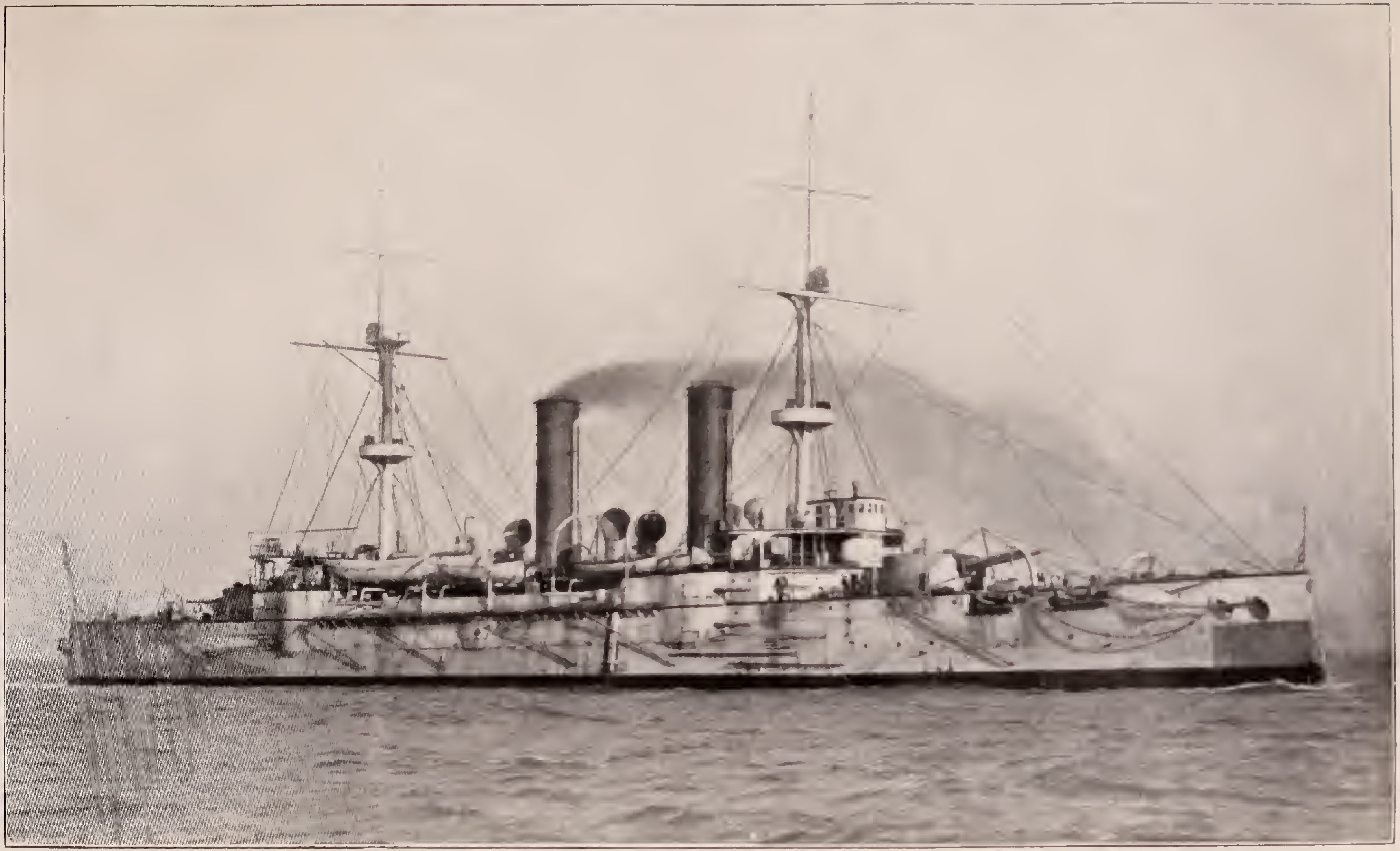
Engines, two sets vertical triple expansion; boilers, Belleville; speed, 21 knots.

TOKIWA.

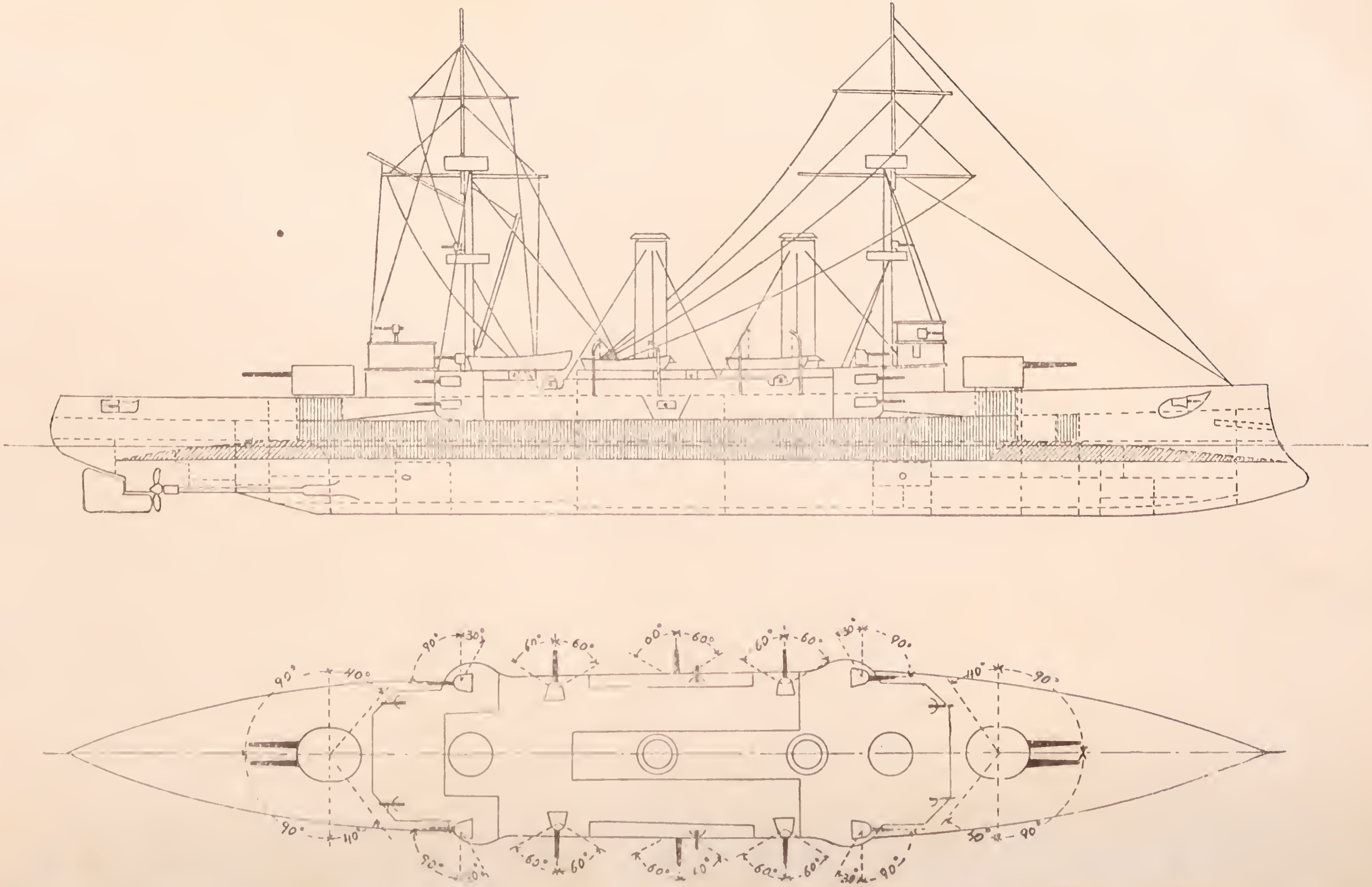
The guns can be so trained that fifteen guns can fire directly ahead, viz, two 8-inch guns, four 6-inch guns, six 12-pounder guns, two 2½-pounder guns, one torpedo. Fourteen guns can fire directly astern, viz, two 8-inch guns, four 6-inch guns, six 12-pounder guns, two 2½-pounder guns; and twenty-five on either broadside, viz, four 8-inch guns, seven 6-inch guns, six 12-pounder guns, six 2½-pounder guns, two torpedoes.

ASAMA.

This cruiser is a formidable fighting ship from every point of view—speed, seagoing quality, offensive armament, defensive armor, and turning power. Her armament includes four 8-inch R. F. guns mounted by pairs, one pair forward and one aft, in gun houses of 6-inch Harveyized steel, with an outer skin of an additional inch, and a flat cover 1 inch thick, with three sighting cowls rising about a foot above the cover. The ammunition hoists open directly into the turrets. The guns in the forward turret are 25 feet above the water line, and the after guns 24 feet. There are fourteen 6-inch R. F. guns, disposed as follows: Ten are in casemates of 6-inch Harveyized steel, two on either side forward and two on either side aft, in pairs over



ASAMA. (Japanese armored cruiser.)



ASAMA. (Japanese armored cruiser.) 9,700 tons.

one another, with one more gun on either side of the main deck, each in an isolated casemate. The remaining four are behind shields, as upper-deck mountings. The lower tier of sponsoned guns is 12½ feet above the water line, the upper about 20 feet. In addition to the above, twelve 12-pounders and seven 2½-pounders, available for boat or land service, are in various parts of the ship. During the gun trials both pairs of 8-inch guns were fired directly either ahead or astern, with 5 degrees elevation, and no injury was done. The four 6-inch guns forward were fired simultaneously and also those aft, the boats, woodwork, and other fittings of the vessel being uninjured. All guns were fired with full charges.

PROTECTION.

The defensive armor, including the armored decks, is stated to weigh 2,100 tons, and is thus disposed: A belt of 7-inch Harveyized steel, 7 feet deep, is along the water line, 2 feet above it and 5 feet below. This belt tapers to 3½ inches at the ends of the vessel. Above the 7-inch belt is another of 5 inches thickness, which reaches beyond the turrets at either end, and is then bent inward and across, forming complete athwart-ship bulkheads, protecting the bases of the turrets and generally shielding the vessel against raking projectiles. A belt of 6-inch plating, which extends 25 feet aft from the stem on either side, protects the bow torpedo tube. The *Asama* is supplied with four under-water torpedo tubes in addition to the one above water forward, and all are intended for torpedoes of 18-inch caliber. The main deck is in two thicknesses, each of one-half inch steel, and the ammunition hoists, where they rise above the deck, are circular tubes of 3-inch steel. The upper deck is covered with teak, and this is practically the only woodwork that can not be disposed of in case of action or fire. The fire main is completely under the armored deck, and has risers at intervals, each with its own valve, so the accidents which occurred in the Spanish ships at Santiago, from the destruction of their fire mains, are guarded against. The bulkheads are of steel, and the doors and cabin fittings alone are of wood. A flat 2-inch steel plate runs horizontally forward to strengthen the lower portion of the ram, of which the upper side is adequately strong from the support afforded by the continuance of the armored deck right up to the stem. The ram is hollow and is not stuffed with cork in small pieces, as is the case in many vessels of many nations, the British included. There is an armored lookout with 14-inch sides at the fore bridge and another aft. The *Asama* has two funnels fore and aft, two masts with fighting tops, and in general appearance resembles the *Canopus* class. The accommodation for officers and men is good, and the head room, nearly 7 feet under the beams, is somewhat better than in the general run of ships.

Arrived at Yokosuka, Japan, May 18, fifty-nine days out from Newcastle, England, making an average run of 12.5 knots all the way Leaving Newcastle a fortnight later than the *Kasagi Kan*, she picke up thirteen days on this vessel, and thus beat the hitherto best war shi run in Japan by ten days.

TAKASAGO AND X.

(Page 189, No. XVI, Part IV.)

	Begun at—	Launched.
Takasago	Elswick	May 11, 1897
X	Elswick (building)	

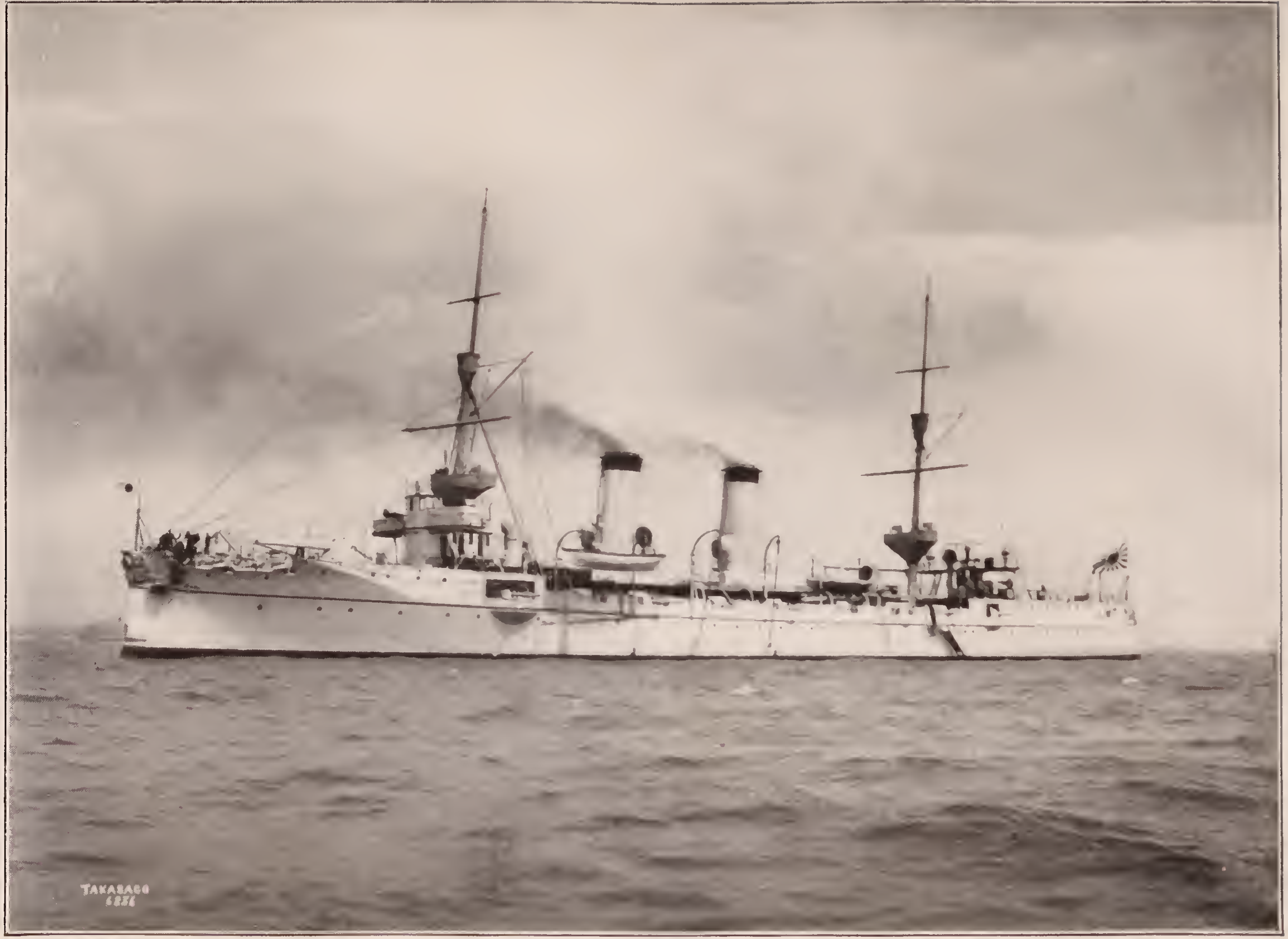
Dimensions.—Length between perpendiculars, 360 feet; breadth, 46 feet 6 inches; draught, 17 feet; displacement, 4,300 tons; I. H. P., 15,500; speed (estimated), 24 knots; coal capacity, 1,000 tons.

Armament.—Two 8-inch, ten 4.7-inch, twelve 12-pounders, six 2½-pounders. Torpedo tubes, five.

One thousand tons coal would probably bring her down at least 2 feet in the water, making her draught about 19 feet. Nevertheless, the *Takasago* has a very good percentage as to coefficient of fineness below the water line, it being 0.53 of the solid rectangle, or slightly higher than that found in the *Edgar* type. Moreover, the vertical character of the lines just above the water-line area lends itself to the carriage of additional fuel without undue immersion, and even a draught of 19 feet is only equal to that of the *Charybdis*, a cruiser of almost identical displacement in the English navy. This vessel is protected by a turtle-back armored deck extending from stem to stern, 2 inches on the flat to 4½ inches thick on the slopes. There are four above-water torpedo tubes on the beam and quarter and one fixed bow tube.

The armament of the *Takasago* is of an exceptionally powerful character when we consider her very moderate displacement.

For a second-class cruiser the *Takasago* is very high out of the water. She has a raised poop and forecastle on which the 8-inch quick firers are carried, protected by large shields 4½ inches thick in front and 2 inches thick at the sides. These raised decks cover in the fore and aft 4.7-inch sponsons. The remaining 4.7-inch guns are distributed amidships behind low bulwarks cut away in embrasures sufficient to give a large arc of training, about 150 degrees. All these 4.7-inch guns are long pieces, with the usual Elswick shield about 2 inches thick in front. The 3-inch 12-pounders are also fitted with gun shields of the same shape. These guns are carried, two on the forecastle above the forward sponsons, two inside the forecastle right forward, two on the poop above the after 4.7-inch sponsons, two inside right aft, and the rest between the 4.7-inch guns. The 2½-pounders are carried a



TAKASAGO. (Japanese cruiser.) 4 160 tons, I. H. P. 15 500; speed 23 knots; launched 1897.

couple in each fighting top and two amidships. These last embody a Japanese invention for rapid closing of the breech. On the top of each breech piece on the right-hand side there is a thick leather pad, a blow of the hand on which instantly brings up the breechblock. As the breech is opened automatically by the recoil of firing, two men can easily manage the gun, and a single man if he had the ammunition handy could maintain a very respectable rate of fire. These 2½-pounders have hooded shields, miniatures of those on the 4.7-inch and 3-inch guns. It is worthy of especial note that the *Takasago's* fighting tops, like the *Yoshino's*, are low. After the Yalu an impression gained ground that the low fighting top was very likely to be hit in action. Stability would be impaired of course were they higher, but at the same time the matter is worthy of comment.

The fighting tops are not circular, as in most war vessels, but kidney-shaped, one lobe being on either side of the masthead. Each lobe has a 2½-pounder mounted within it, upon a pedestal, which revolves with a capacious steel shield to protect the men working the gun. The kidney-shaped tops are supported and stiffened with strong steel brackets, so as to sustain the weight of guns with mountings and shields. It is to be feared, however, that their weight in a seaway would somewhat impair the stiffness of so narrow a vessel, particularly as the 8-inch guns are carried at a great height, and their weight being over 15 tons, independently of the mounting.

The axial fire fore and aft of the *Takasago* is very remarkable in hitting power. The number of guns which can be trained in this direction, either way, is as follows, and their hitting energy is also given for five minutes' consecutive fire:

Axially, forward or aft.	Rounds in five minutes.	Working energy in foot-tons.
One 8-inch quick firer	15	111,195
Two 4.7-inch quick firers	50	72,100
Two 12-pounders	100	42,000
Two 2½-pounders	200	14,000
	365	239,295

The aggregate amount of fire energy which would be developed by five minutes' consecutive fire from all the guns of this cruiser would be 876,890, or practically 1,000,000 of foot-tons. This is by no means admitting of very rapid rates of firing, but with such only as have been obtained in ordinary practice.

A distinguishing feature of the *Takasago* is the absence of excessive superstructure and the very modest proportion of cowls which is employed. Possibly artificial ventilation is resorted to in a larger measure than is the case upon British and most other war vessels, but the difference is striking.

A comparative statement is given of the various features of the *Takasago* and of the *Astræa*, one of the English vessels of equivalent type and displacement—

	Takasago.	Astræa.
Length between perpendiculars....feet..	360	320
Beam....do....	46½	49½
Draught....do....	17	19
Displacement....tons..	4,300	4,360
Maximum horsepower....	15,500	9,112
Normal coal capacity....tons..	Not known.	400
Normal bunker capacity....do....	1,000	Not known.
Speed, maximum....knots..	24	19¾
Armament, guns:		
8-inch R. F....	2	....
6-inch R. F....	....	2
4.7-inch R. F....	10	8
12-pounder R. F....	12	....
6-pounder R. F....	....	8
3-pounder R. F....	....	1
2½-pounder R. F....	6	....
Aggregate gun power developed by five minutes' consecutive fire, foot-tons....	876,980	601,400

Showing an increased proportion of 50 per cent of striking energy in foot-tons in favor of the Japanese cruiser. This is scarcely a pleasing reflection. The propelling engines are by Messrs. Humphry and Tennant.

The conning tower is 4½-inch Harveyed nickel, and is surmounted by a bridge. There is also an after bridge. A fore-and-aft bridge runs along the port side from poop to forecastle.

The torpedo tubes are five in number, one fixed tube in the bow and training tubes on the beam and quarter. There is no stern tube.

The armored deck is 4½ inches thick at the slopes, 2½ inches on the flat top.

The lower deck is of steel, covered thickly with linoleum in order to avoid the risk of fire in a part where fires are most dangerous and difficult to deal with in action. There is, however, none of that total abolition of wood so characteristic of the latest ships. The upper deck is, as usual, composed of wood; the Japanese prefer this, holding that a complete wooden deck gives a rigidity far superior to steel, and that fires here are so easily dealt with that the extra risk need not be seriously considered.

There are two sets of vertical triple-expansion engines, and eight boilers, four of them double-ended. The horsepower is 15,000, the trial speed over 23 knots. The sea speed is 21 knots. One thousand tons of coal can be carried, but the normal coal capacity is about 800 tons. The ship, according to her officers, is a roller, as might be expected. She pitches very little indeed.

CHITOSE.

Built at Union Iron Works, San Francisco, Cal.; second-class cruiser; is a substantial duplication of the *Buenos Aires*, built at Elswick in 1895 for the Argentine Republic, with some modifications in armament, and may be said to be a development of the *Yoshino*.

Dimensions.—Length, 405 feet 2 inches; breadth, 49 feet; draught, 17 feet 7.25 inches; displacement, 4,760 tons.

Armament.—Two 8-inch R. F., ten 4.7-inch R. F., twelve 12-pounders, six 2½-pounders.

Engines, triple expansion; coal capacity, 350 tons; bunker capacity, 1,000 tons; speed, 22.5 knots; complement, 405 men.

Protection.—A protective deck, reaching from side to side and running from the stem to the stern, completely covers the vitals. On the flat portions of this deck it is 1¾ inches thick, but on the slopes at the sides it is increased to 4½ inches.

All woodwork is to be fireproofed by the present prevailing electrical process.

One 8-inch gun is mounted on the forecastle deck, the other on the poop deck, and each has a commanding arc of fire of 270 degrees. The gun crews are protected by shields on each piece. These 8-inch guns are of the Armstrong type, and, together with the rest of the batteries, will be purchased in England and placed on board the ship when she reaches Japan. The 4.7-inch guns are mounted in sponsons on the main deck and are sheltered by shields and the 3-inch sponson armor. The forward gun on each side and the after gun on each side have separately an arc of fire of 130 degrees, the forward guns being able to fire dead ahead and the after guns being able to fire dead astern. The rest of the 4.7-inch guns and such of the 12-pounders as are sandwiched between on the main deck have arcs of fire of 100 degrees. The 12-pounders have the same 3-inch sponson armor about them. The four remaining 12-pounders are mounted forward and aft in sponsons near the bow and stern. The 2½-pounders are placed on the hammock berthing and up in the military tops. The 8-inch and the 4.7-inch guns will be supplied with ammunition by electrical hoists, while the supplies for the smaller guns will be raised by whips from the magazines.

ELECTRICAL EQUIPMENT.

The electric current, both for lighting and power, is produced by three generating sets of 32-kilowatts capacity each. These are direct-current generators, compounded for a constant potential of 80 volts, direct coupled to compound balanced engines making 400 revolutions per minute. They are so arranged that any set can be used either on motors or lighting circuits.

The requirements of these generating sets are the same as those being built for the United States battleship *Wisconsin*, which will have eight sets from the same patterns.

The wiring installation will consist in general of nine lighting, four searchlight, and two motor circuits, so arranged at the switch board as to permit of all the circuits working off the three generating sets in multiple, or the lighting circuits on one generator, the searchlights on another, and the motors on the third, independently. The fixtures to be installed will give outlets for 379 lights.

There will be one rotary transformer for reducing the dynamo potential from 80 to 10 volts, for operating call and signal bell service, and also another for reducing to 6 volts, for firing the guns of the main battery.

There will be ten portable electric fans for the ventilation of spaces not reached by the general ventilation system of the vessel.

The searchlights are to be of the Mangin type, 24 inches in diameter, fitted for electric control at a distance and with variable diverging doors, by means of which the projected ray can be used as a parallel beam of great intensity for long-distance work, or spread out fan shaped, to cover a greater area at a shorter distance.

The entire system will be installed on the two-wire plan, operated at 80 volts. There will be ordinary service circuits and battle circuits, the latter being run under the protected deck. All wires are covered with extra heavy rubber insulation, protected by braid soaked in waterproof compound.

Through boiler and engine compartments the wires will be in iron-armored conduit; elsewhere, except the running-light circuits and those running up the masts, the wire will be in wood molding. All connections are made through water-tight junction boxes, and not more than two lights are taken off any one fuse. Stuffing boxes are fitted for the wires at all water-tight bulkheads and decks through which they pass.

There are to be ten electric ammunition hoists, as follows: Two 8-inch shell and powder hoists, four 4.7-inch shell and powder hoists, two 12-pounder fixed-ammunition hoists, two 2½-pounder fixed-ammunition hoists. All of these hoists are to be of the continuous-running, endless-chain type, delivering on the gun deck through armored hoods. The traveling carriages are suspended on flat-link chains working over sprocket wheels. The carriages are to be guided on each side by rollers working in guide rails.

The 8-inch and 4.7-inch hoists are designed to receive and deliver on the same side, and the 12-pounder and 2½-pounder hoists are designed to receive one side and deliver on the other. All the hoists are faced inside on the working sides with hard wood.

Safety catches are provided and spaced about 6 feet apart, to prevent the shell or powder dropping back should the chain be broken at any point. The safety catches are provided with relieving gear for throwing them out of gear, to enable ammunition to be lowered from the deck above to the magazines.

The carriages are of bronze, suspended between the chains on steel pins securely attached to the chain links.

The hoists are to be fitted, if necessary, to discharge on the deck below the regular discharge. The object of this provision is to be able to serve the guns through ammunition scuttles by hand from below at close quarters, when the upper decks might be swept by the fire of machine guns.

Current for the hoists will be taken from either of two mains, one for the forward hoists and one for the after hoists, leading from the dynamo room through iron-armored conduit. These two main feeders will be connected to the main switch board in such a manner as to be supplied by either dynamo singly or from dynamos operating on lighting circuits.

Each 8-inch hoist is to be capable of delivering three rounds per minute to its respective gun. A round consists of one shell and two powder tanks, each being handled separately. These hoists will be fitted with six carriages and the chains will have a maximum speed of 100 feet per minute. The armored hood on deck will be partly masked by an extension of the conning tower, the front only being exposed. The interior of the hood will be fitted with a drum mounted on the sprocket-wheel shaft, having a recess to receive the charges, and so arranged as to close the openings except at the instant of discharging or receiving a charge. This is an important and necessary function, as the principal danger of derangement to this kind of ammunition hoist is from splinters and débris getting into the hoist casing and wrecking the moving parts.

The casing on the gun deck for the after 8-inch hoist accommodates also the 12-pounder and 2½-pounder hoists. All doors in the armored hoods are water-tight when closed, and are arranged to act when open as discharge or feeding tables for the ammunition.

The 4.7-inch hoists are similar in design to the 8-inch hoists. Each will be capable of delivering 20 shells or 20 powder tanks per minute at full capacity. The forward hoists will have nine carriages and the after hoists eight carriages each. The arrangement of hoists and gears in the handling rooms will be such that either motor or the hand gear can run its own or both hoists and that either hoist can be used for powder or shell.

The 12-pounder and 2½-pounder hoists will be alike in design. Each will be capable of delivering four boxes of shells and two boxes of powder for 2½-pounder and the same for 12-pounder guns. Suitable tightening gear has been provided for adjusting the tension of the chains for each hoist.

The introduction into modern ships of war of quick-firing ordnance up to 8 inches has made the serving of ammunition one of the many difficult problems that confront the naval architect and the engineer. It also gives an idea of how long a naval engagement will last between modern ships, if they have to do their best, to consider that a ship equipped as the *Chitose* will be can fire all the ammunition she can carry in two hours.

KASAGI.

Built at Philadelphia; launched in 1897.

Dimensions.—Length between perpendiculars, 396 feet; breadth, 49 feet; draught, 17 feet 7 inches; displacement, 4,760 tons.

Armament.—Two 8-inch R. F.; ten 4.7-inch R. F.; twelve 12-pounder R. F.; four 2½-pounder R. F. Torpedo tubes, five, above water.

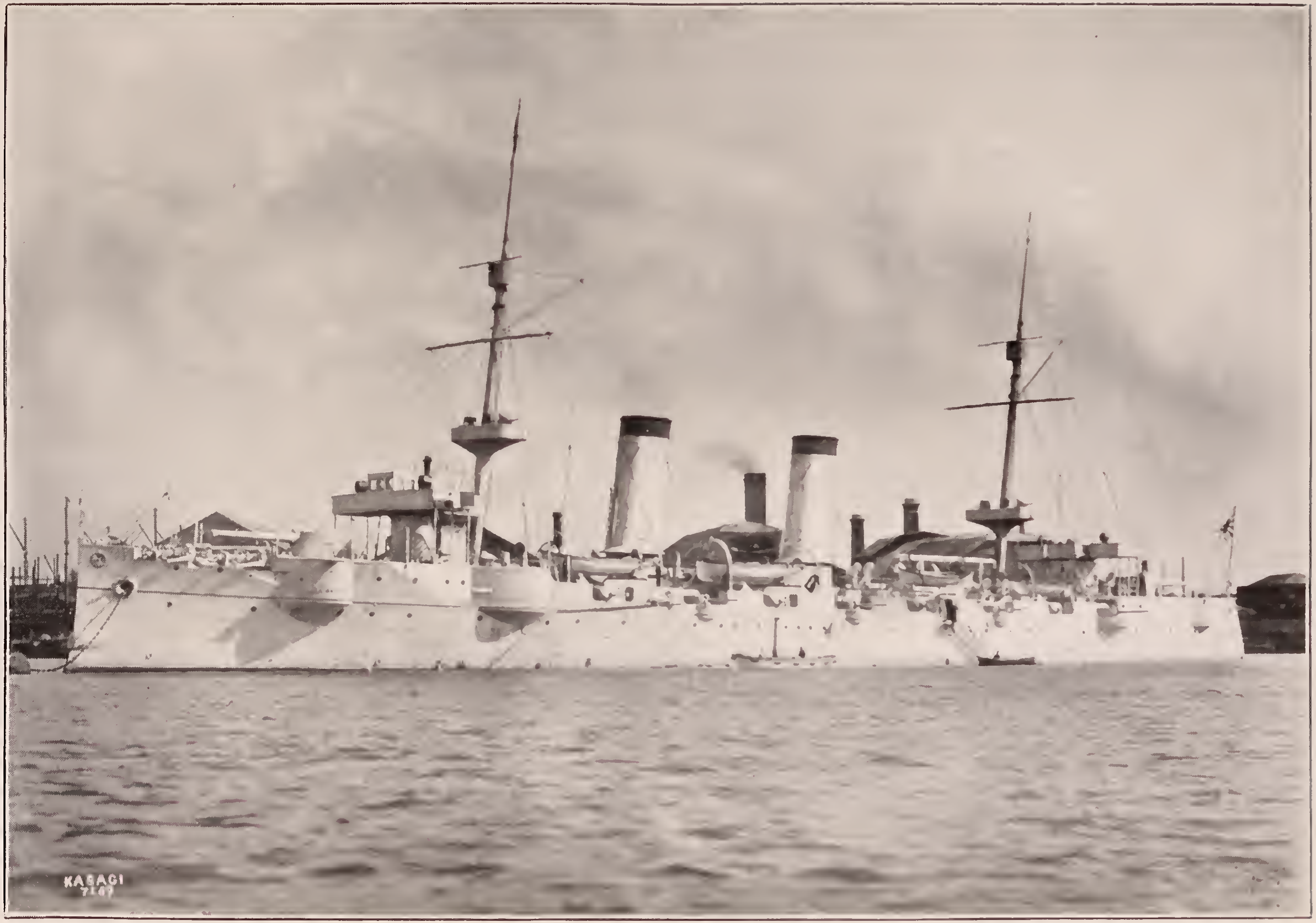
I. H. P., 15,500; speed, 22½ knots; coal capacity, 1,020 tons (bunkers, extreme).

Protection.—She has an armored steel deck, 2 inches thick over the flat and 4½ inches over the slopes.

One of the five above-water torpedo tubes is at the bow of the vessel, and 25 torpedoes are contained in the torpedo racks on board as the unit for ordinary service. The bodies of these torpedoes are carried in cases of racks of steel wire netting, which is an excellent arrangement, and preserves the rudders and propellers from all possibility of accident.

One distinguishing feature in the *Kasagi* is the absence of wood everywhere; decks, excepting the lower ones, partitions of cabins, sides and treads of companion ladders, ceilings of cabins, and nearly all other features which in ships have been immemorially constructed of wood are here found to be of steel or some other metal. The captain's cabins are ceiled with embossed steel, excessively thin, and yielding to the pressure of the hand. The stamped and embossed ornaments give these apartments a very handsome appearance. The spokes and rims of the steering wheels are all of gun metal. The men's mess tables are about the only articles which are made of wood, but the seats upon which the men sit at meals are sheet-steel boxes with steel lids, in which their kits—mess gear, etc.—are kept. To prevent discomfort each man is allowed a little loose board to place upon the top of his box seat. These should be heaved overboard in action. In the officers' lavatories there are capital enameled baths, washstands, and other articles, but all are of metal, not a scrap of wood being observable anywhere.

The artificers' workshop is very complete, and three good-sized lathes, together with drilling machines and other machinery, all worked by steam, are fitted; but there is observed everywhere an absence of



KASAGI. (Japanese cruiser.) 5,416 tons; I. H. P. 15,797; speed, 22.5 knots; launched 1897.

spare parts and stores. The conning tower of the *Kasagi* is differently constructed from those on board British war vessels. The top, instead of being removable, so as to afford a lookout all round, is attached to the sides, and horizontal slits only are left for taking observations. This is possibly a wise arrangement, for there is always a chance of the cover of such conning towers being lifted off by a blow from a large projectile. There appear to be no voice-tube exchange stations on board. Mouthpieces of tubes extending to almost every position are fixed within the conning tower itself. The arrangement of anchors is curious, two being on beds upon the port side and one upon the starboard, vice versa to the plan on board vessels generally.

The 8-inch guns, two in number, are mounted fore and aft upon the forecastle and poop, within very large and roomy steel hoods, 4½ inches thick. They are capable of containing, each, almost a whole gun's crew of the medium-sized, wiry Japanese blue jackets. In rear of each gun position is the circular mouth of an armored hoist leading down to the magazines. It projects slightly out of the deck, and has a hemispherical solid steel cap to cover it, which opens and shuts. When open the ammunition hoist is seen, which works on endless chains over a roller at the top, and runs out the cartridges (in cylinders) and projectiles on to a loading tray. A small gun-metal tramway on the decks runs past the hoist, and from each extremity of the gun's possible arc of training. It has trolleys on it for conveying the projectiles to the various loading positions, and the lines have loops for the full and empty trolleys to pass one another.

The 4.7-inch quick-firing guns, which are on either broadside, have also good-sized steel shields 4½ inches thick, and are sponsoned out, so that the forward and aft pairs can point directly ahead or astern, according to their position in the ship, with an arc of training of 180°, while those between have an arc of training of 100°. Of course the shields thin off toward the rear. The forward pair is casemated. Armored tubes protect the ammunition en route from the magazines, and a hatch, covered with an armored circular cap, somewhat similar to that employed for the 8-inch guns, surmounts the hoist for ammunition and projectiles. It should be mentioned that all the ammunition hoists are worked by electric motors, which actuate an endless chain at the side.

The 12-pounder guns have lighter shields, and they occupy intermediate positions between the 4.7-inch quick-firers, with the exception of the forward and after pair, which are within casemates of stout steel plating beneath the forecastle and within the captain's cabin, respectively. The ammunition for the 12-pounders is also brought up by an electric hoist through an armored tube, and opens by a large hatchway into a small, armor-protected square deck house beneath the poop deck. This is an excellent arrangement for protecting the 12-pounder ammunition until it arrives on deck; from thence it is served to the guns.

Four 2½-pounder Japanese quick firers are in the tops. They have large shields of a different shape from those employed in British tops, but somewhat similar to those of the broadside 12-pounders, only smaller and lighter, of course.

The unit of ammunition carried for the guns of this vessel on ordinary service is as follows: One hundred rounds for each 8-inch gun, 200 rounds for each 4.7-inch gun, 300 rounds for each 12-pounder, and 400 rounds for each 2½-pounder. These units are doubled when the ship is dispatched on war service. It is said that the whole of this quantity of ammunition could be carried in the magazines, but it is possible that the question may not have been fully understood. It appears a very extraordinary amount to maintain in the magazines, even in the eventualities of war.

The totals of the weights of ordinary ammunition would be as follows:

	Pounds.
Two 8-inch quick-firing guns, 200 projectiles	50,000
Charges with metal cylinders	15,000
Ten 4.7-inch R. F. guns, 2,000 projectiles	90,000
Charges with metal cylinders	40,600
Twelve 12-pounder guns, 3,600 projectiles	43,200
Charges with metal cylinders	18,000
Four 2½-pounder guns, 1,600 projectiles, with charges	6,000

Or, roughly, with blank and saluting ammunition, about 120 or 130 tons. And on active service the quantity would be doubled.

The mountings and shields of the 8-inch quick-firers are rotated by electric motors, and it is said that the whole of the arc of 270 degrees could be passed over easily in one minute. Elevation is also accomplished by a small motor. The movements can, however, be carried into effect by hand and hand-gear wheels, which worked with the utmost ease and smoothness when tested. The opening and closing of the breech was effected by a hand wheel between the breech and the trunnion axis. Four rounds can be fired in 64 seconds.

The *Kasagi* does not present a favorable appearance. The large projecting sponsons, two heavy guns and mountings fore and aft, weighing each over 30 tons, gave the impression of far too much top weight. Perched, as the latter were, upon the poop and forecastle, with 30 tons' weight so close to the stem, and three anchors besides, to say nothing of chain cables, etc., it would seem that the *Kasagi* would plunge and make very bad weather in a heavy sea. And the proximity of the broadside guns to one another is so remarkable that there would hardly be room to work them. It certainly does seem singular that a vessel only 400 tons superior in displacement to the *Fox* can carry an armament so immensely superior in weight of metal and in actual numbers, the following being a comparative statement:

FOX.	KASAGI.
Two 6-inch R. F.	Two 8-inch R. F.
Eight 4.7-inch R. F.	Ten 4.7-inch R. F.
Eight 6-pounder R. F.	Twelve 12-pounder R. F.
One 3-pounder R. F.	Four 2½-pounder R. F.

This, too, is independent of the question of coal capacity and engine power. The Japanese cruiser is better off by 50 per cent as regards the first item. As regards the second, there is a difference of no less than 3 knots in favor of the *Kasagi*.

TRIALS.

Trial trip with rough water and a strong tide setting almost at right angles with the course, a mean average speed of 22.75 knots per hour was developed. The course was 20 miles long in four legs, and the following table shows the results of up and down the course, a total of 40 miles.

	Elapsed time.		Speed.
Run up:	*Min.*	*Sec.*	*Knots.*
First lap	12	54	23.25
Second lap	13	7	22.90
Third lap	13	0	23.07
Fourth lap	13	0	23.07
Total intervals, 52 minutes 9 seconds. Average, 23 knots.			
Run down:			
First lap	13	14½	22.65
Second lap	13	11	22.67
Third lap	13	33	22.12
Fourth lap	13	19	22.55
Total intervals, 53 minutes 20 seconds. Average, 22½ knots. Mean speed for the run, 22.75 knots.			

The revolutions rose from 158 at the beginning of the run to 164 at the end. To show the perfect condition of the machinery, a series of progressive trials was run as soon as the main trial was over, in order to get the speed at 80, 125, 150, and 162 revolutions.

PORTUGAL.

DON CARLOS I.

(Page 195, No. XVI, Part IV; page 29, No. XVII, Part I.)

	Builders.	Date of launch.
Don Carlos I	Armstrong, Whitworth & Co., Elswick	May 5, 1898.

Material of hull, steel, sheathed with wood and coppered: form of bow, ram; rig, two steel masts, each carrying two fighting tops.

Dimensions.—Length between perpendiculars, 360 feet; over all, 387 feet; extreme breadth of beam, 47 feet 3 inches; draught, forward, aft, and mean, 17 feet 6 inches; displacement, 4,250 tons.

Armament.—Four 6-inch R. F.; eight 4.7-inch R. F.; twelve 47-millimeter (3-pounder) R. F.; six 37-millimeter (1-pounder) R. F.; four mitrailleuses. Torpedo: Three submerged tubes, two above-water tubes.

Tactical data.—Searchlights, three.

Protection.—Hull protection, none. Double bottom and water-tight compartments. Cofferdam around engines and boilers.

Protective deck: Armored deck with sloping sides of 4-inch armor; thickness, 1.75 inches on the flat and 4 inches on the slopes, extends from stem to stern.

Turrets, barbettes, redoubts: Conning tower, 100 millimeters (3.94 inches) of armor.

Motive Power.—Engines, two vertical triple-expansion, with two low-pressure cylinders and four cranks, constructed by Messrs. Hawthorn, Leslie & Co. Diameters of cylinders: High pressure, 30.5 inches; intermediate, 49 inches, and the two low pressure each 56 inches; stroke, 27 inches. Cooling surface of condensers, 12,500 feet.

Boilers: Twelve, of Yarrow type. Total heating surface, 32,000 square feet, working at a pressure of 300 pounds to the square inch, reduced to 250 pounds at the engines. Total grate area in square feet, 587. Total weight of boilers, uptakes, and funnels, in tons, 217; total weight of water in boilers, in tons, 30.

Screws: Two.

Coal.—Capacity at load water line, 700 tons; total capacity, 1,000 tons; endurance at maximum speed at 12 knots, 10,000 miles.

ARMAMENT.

One of the 6-inch guns is mounted on the forecastle, one on the poop, and the remaining two on the upper deck. The eight 4.7-inch guns are mounted on the upper deck, the after pair firing directly astern. Two of the 3-pounder guns are mounted on the upper deck under the forecastle with direct fire ahead, two under the poop with direct fire astern, two in each lower fighting top, and four on the bulwarks amidships. Two of the 1-pounder guns are mounted on the poop and the other four on the bulwarks. Two of the mitrailleuses are in the upper top and two on the forecastle.

The 4.7-inch guns are protected by 76-millimeter (3-inch) shields.

Three of the torpedo tubes are submerged, one being in the lower part of the stem with direct-ahead fire, and two on the broadside forward, all being fixed. The two above-water tubes are in a compartment abaft the machinery, and have large arcs of training. The bow tube is immediately under the point of the ram.

ELECTRICAL EQUIPMENT.

A complete installation of incandescent lamps is provided throughout the ship, with the necessary engines and dynamos.

PROTECTION.

Conning tower (4 inches in thickness) placed on after end of forecastle.

SAO RAFAËL AND SAO GABRIEL.

Name.	Descriptive and explanatory remarks.
Sao Rafaël	Cruisers, third class; long, raised poop and forecastle, with short waist, nearly stringht stem.
Sao Gabriel	

	Builders.	Keel laid.	Date of launch.
Sao Rafaël	Graville yard, Société des Forges et Chantiers de la Méditerranée, Havre, France.	Apr., 1897	July 5, 1898
Sao Gabriel		Apr., 1897	May 7, 1898

Material of hull, steel, sheathed with wood and coppered; form of bow, slight ram; number of funnels, one; rig, three pole masts with yards on foremast.

Dimensions.—Length, 246 feet; extreme breadth of beam, 35 feet 6 inches; draught, mean, 14 feet 2 inches; displacement, 1,800 tons.

Armament.—Two 15-centimeter (5.9-inch) R. F.; four 12-centimeter (4.7-inch) R. F.; eight 3-pounder R. F. (47-millimeter), Canet pattern; two machine guns. Torpedo, one, above-water, in bow.

Protection.—Hull protection: One inch of horizontal armor over engines and boilers. No double bottom.

Protective deck: Twenty millimeters on flat portion (0.787 inches), and 40 millimeters (1.57 inches) on the slopes. Cofferdams of Cauville pattern.

Turrets, barbettes, redoubts: Electric ammunition hoists, Noria type.

Motive power.—Engines: Two triple-expansion engines, vertical.

Boilers: Two Normand-Sigaudy boilers, and 1 auxiliary.

Screws: Two.

Coal.—Capacity at load water line, 500 tons.

ARMAMENT.

Battery built by Schneider & Co., at Havre. Two 5.9-inch R. F. guns on poop and forecastle; four 4.7-inch R. F. guns in sponsons on broadside on upper deck; four light R. F. guns on upper deck; machine guns on poop and bridge.

ELECTRICAL INSTALLMENT.

Each ship lighted by electricity. The service for lighting, for the Mangin searchlights (Sautter Harlé type), of the various ventilators, and of the ammunition hoists is generated by two dynamos of 200 amperes and 80 volts, installed with the auxiliary apparatus.

PROTECTION.

Battery not protected, and, according to a profile plan seen, they carry no shields; magazines electrically ventilated; transverse water-tight bulkheads; double longitudinal cofferdam extends from the torpedo compartment to the stern, rising from the armored deck to 1 meter above the water line.

4. TRIALS.

ENGLAND.

Name.	Displacement.	Class.	Natural draft.			Forced draft.		Endurance.		
			Time.	Power.	Speed.	Time.	Speed.	Time.	Power.	Speed.
	Tons.		*Hrs.*		*Kts.*	*Hrs.*	*Kts.*	*Hrs.*		*Kts.*
Albatross	360	Torpedo-boat destroyer.					[1]32.29			
Amphitrite	11,000	Cruiser, first class.			19.73		20.78			
Argonaut	11,000	do		Four-fifths	19.94		21.14		One-fifth	13.16
Ariadne	11,000	do		do	20.10	5	21.50		do	13.3
Barham	1,830	Cruiser, third class	8		18.60		19.00			
Canopus	12,950	Battleship, first-class.		Four-fifths	17.20	8	18.50			
Cheerful	308	Torpedo-boat destroyer.					[2]29.94			
Cygnet	285	do				3	30.30			
Dwarf	700	Gunboat, first class	8		13.10	4	14.15	30		11.6
Express	300	Torpedo-boat destroyer.					32.00			
Fox	4,360	Cruiser, second class.					[3]17.00			
Goliath	12,950	Battleship, first class.		Four-fifths	17.32				One-fifth	11.7
Hermes	5,600	Cruiser, second class.					20.50			
Highflyer	5,600	do	8		20.10	8	21.10			19.4
Flirt	324	Torpedo-boat destroyer.						8		13.0
Kestrel	300	do					[4]30.41			
Leven	300	do				3	30.20			
Pioneer	2,200	Cruiser, third class	8		17.60	8	20.00	30		16.3
Lynx	280	Torpedo-boat destroyer.					23.80			
Mermaid	308	do				3	30.83			

[1] Preliminary.

[2] Second trial, 30.21 knots.

[3] Paying-off trial.

[4] Six runs, measured mile.

4. Trials—Continued.

ENGLAND—Continued.

Name.	Displacement.	Class.	Natural draft.			Forced draft.		Endurance.		
			Time.	Power.	Speed.	Time.	Speed.	Time.	Power.	Speed.
	Tons.		*Hrs.*		*Kts.*	*Hrs.*	*Kts.*	*Hrs.*		*Kts.*
Ocean	12,950	Battleship, first class.	30	Four-fifths	16.20	8	18.50		One-fifth	11.4
Orwell	300	Torpedo-boat destroyer.				3	30.20			
Perseus	2,135	Cruiser, third class	8	Full	19.10	4	20.00	30	One-half	17.2
Prometheus	2,135	do	8	do	19.80	4	20.80	30	do	17.5
Otter	300	Torpedo-boat destroyer.				6	30.20			
Pyramus	2,135	Cruiser, third-class	8	Full	19.90	4	20.70	30	One-half	17.49
Pomone	2,135	do	8	do	20.20	4	20.80	30	do	16.5
Seagull	735	Torpedo gunboat.				3	19.53			
Sheldrake[1]	735	do								
Wolf	300	Torpedo-boat destroyer.				2	27.00			
Thistle	700	Gunboat, first class	8	Full	13.00	4	13.50	30		11.5
Psyche	2,200	Cruiser, third class	8	do	19.50	4	20.48	30	One-half	16.8
Gladiator	5,800	Cruiser, second class.	30	Three-fifths.	17.50	8	19.10	30	One-fifth	11.8
Coquette	285	Torpedo-boat destroyer.			30.21					
Pique	3,600	Cruiser, second class.	2		18.50					
Spiteful	322	Torpedo-boat destroyer.				3	29.90			
Bellona	1,830	Cruiser, third class	8	Full	18.80		[2]19.75			
Cynthia	285	Torpedo-boat destroyer.				3	30.30			
Bullfinch	300	do					[4]30.00			

FRANCE.

Name.	Displacement.	Class.	Natural draft.			Forced draft.		Endurance.		
			Time.	Power.	Speed.	Time.	Speed.	Time.	Power.	Speed.
Dunois	896	Torpedo gunboat.					[3]21.70			
Durandal	300	Torpedo-boat destroyer.				6	[4]27.40			
Guichen	8,277	Cruiser, first class.					[3]22.00			
Lansquenet	150	Torpedo-boat destroyer.					(5)			
No. 218	86	Torpedo boat					[6]25.00			
La Hire	896	Torpedo-boat destroyer.					[3]21.50			
Hallebarde	300	do	5		22.00	1	27.20			
Suchet	3.334	Cruiser, second class.					20.41			
Lavoisier	2,317	Cruiser, third class					21.40			
Tage	7,589	Cruiser, first class.			18.00					

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[1] See full report.
[2] Refit trial.
[3] Contract=23 knots.
[4] Contract=26.4.
[5] Satisfactory.
[6] Contract=24.

4. *Trials*—Continued.

RUSSIA.

Name.	Displacement.	Class.	Natural draft.			Forced draft.		Endurance.		
			Time.	Power.	Speed.	Time.	Speed.	Time.	Power.	Speed.
	Tons.		*Hrs.*		*Kts.*	*Hrs.*	*Kts.*	*Hrs.*		*Kts.*
Ermack	8,000	Ice breaker					16.5			
Poltava	10,960	Battleship, first class.				12	16.29			
Giliak	963	Gunboat				6	11.25			

GERMANY.

Name.	Displacement.	Class.	Natural draft.			Forced draft.		Endurance.		
			Time.	Power.	Speed.	Time.	Speed.	Time.	Power.	Speed.
Victoria Luise.	5,650	Cruiser					19.10			
Sachsen	7,441	Battleship, fourth class.				3	14.50			

ITALY.

Name.	Displacement.	Class.	Natural draft.			Forced draft.		Endurance.		
			Time.	Power.	Speed.	Time.	Speed.	Time.	Power.	Speed.
Vettor Pisani.	6,500	Armored cruiser			17.50					
Fulmine	260	Torpedo-boat destroyer.			28.00					
Condore	136	Torpedo-boat			26.50					

JAPAN.

Name.	Displacement.	Class.	Natural draft.			Forced draft.		Endurance.		
			Time.	Power.	Speed.	Time.	Speed.	Time.	Power.	Speed.
Akebono	311	Torpedo-boat destroyer.					31.16			
Asama	9,700	Cruiser, first class.			20.37		22.07			
Chitose	4,760	Cruiser, second class.					[1] 22.87			
Tokiwa	9,700	Cruiser, first class.			20.85		22.73			
Yuguri	279	Torpedo-boat destroyer.				3	30.15			
Sazanami	311	do					31.30			
Shinonome	279	do					30.23			
Ikadsuchi	311	do					31+			
Kagero	279	do				3	[2] 30.21			
Shikishima	14,850	Battleship, first class.					19.02			
Oboro	311	Torpedo-boat destroyer.				(3)				

AUSTRIA.

Name.	Displacement.	Class.	Natural draft.			Forced draft.		Endurance.		
			Time.	Power.	Speed.	Time.	Speed.	Time.	Power.	Speed.
Python	133	Torpedo-boat destroyer.				3	24.30			
Zenta	2,250	Torpedo gunboat.	4		20.90					

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[1] Highest speed, 23.76 knots.

[2] Measured mile, 30.54 knots.

[3] Successful.

4. *Trials*—Continued.

CHILE.

Name.	Displacement.	Class.	Natural draft.			Forced draft.		Endurance.		
			Time.	Power.	Speed.	Time.	Speed.	Time.	Power.	Speed.
	Tons.		*Hrs.*		*Kts.*	*Hrs.*	*Kts.*	*Hrs.*		*Kts.*
General Baquedano.	2,330	School-ship	.....	....	......	.....	13.50	.....	....	......
CHINA.										
Hai-Lung	280	Torpedo-boat destroyer.	.....	....	.....	.....	35.20	.....	....	......
Hai-Tien	4,300	Cruiser	.....	....	.....	.....	[1]22.64	.....	....	......
PORTUGAL.										
Don Carlos I.	4,250	....	.....	....	20.66	.....	22.15	.....	....	......
São Gabriel	1,800	....	.....	....	15.75	.....	17.53	.....	....	......
São Rafael	1,800	....	.....	....	15.75	.....	17.53	.....	....	......

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[1] Highest speed, 24.1 knots.

BATTLESHIPS.

ENGLAND.

CANOPUS.

(Page 174, No. XVI, Part IV; 51, No. XV.)

Her first run at one-fifth power was unsatisfactory, owing to the heavy consumption of coal caused by the waste of water due to leaky joints. Subsequently she completed two more trials at one-fifth and four-fifths of her power successfully, each run having been for thirty hours. The ship was on an even keel, the draught being 26 feet fore and aft; the steam in the boilers at the one-fifth power run was 230 pounds to the square inch, and at the four-fifths trial 255 pounds; the vacuum at the one-fifth power run was 27.2 inches starboard and 27 inches port, and during the four-fifths power trial 26.5 inches starboard and 26.2 inches port; while the revolutions were 64.5 starboard and 63.9 port, and 100.1 starboard and 99.3 port on the two runs, respectively. During the one-fifth power trial the engines developed 2,812 I. H. P., with a coal consumption for all purposes of 1.28 pounds per unit of horsepower per hour, and during the four-fifths power run 10,454 I. H. P., with a coal consumption of 1.68 pounds for all purposes per horsepower per hour. The speed at the economical trial was not taken, but at the four-fifths power run the patent log recorded a mean speed of 17.2 knots.

At the eight hours' full-speed trial the ship was on an even keel, drawing 26 feet; the pressure of steam in the boilers was 289 pounds, and the vacuum 25 inches starboard, and 25.9 inches port. The engines worked with such evenness that as the mean of the eight hours' run they each showed 108.5 revolutions a minute, with a collective I. H. P. of 13,763, being 263 horsepower over the contract. The mean air pressure was 0.19 inch, and the mean speed was 18.5 knots, with a coal consumption of 1.72 pounds per horsepower per hour. The weather was warm. In the design 18.25 knots was anticipated.

OCEAN.

(Page 51, No. XV; 175, No. XVI, Part IV.)

This vessel is the first ship of the *Canopus* type to undergo her steam trials, and is also interesting as being the first battleship in Her Majesty's service which has been tried with Belleville boilers.

On July 26, 1899, the vessel was taken to sea for her preliminary trial, and the machinery was worked gradually up to about 100 revolutions. Everything worked without the slightest difficulty, and on the 27th the vessel proceeded to sea for her thirty hours' trial at one-fifth power. The trial passed off most satisfactorily, no difficulties of any sort being experienced, the machinery running very smoothly without the slightest signs of heating. It will be noticed that the coal consumption is 1.84 per indicated horsepower. It should be mentioned, however, that the modifications which have been made to the auxiliary exhaust system in several recent ships, with such successful results in the matter of coal consumption, could not be carried out on board the *Ocean* without delaying the trials, and it was therefore decided that these modifications would be made after the ship was taken over.

Mean results of thirty hours' trial.

	Starboard.	Port.
Mean steam:		
In boilers ....pounds..	210	210
At engines ....do....	184	184
Mean vacuum ....inches..	27.8	27.5
Mean revolutions........	66.6	67.0
Mean pressure in cylinders:		
High........	41.6	38.2
Intermediate	16.2	15.4
Low	4.6	4.2
Indicated horsepower:		
High	506	466
Intermediate	527	501
Low	398	369
Total indicated horsepower	1,431	1,336
Gross total indicated horsepower	2,767	
Coal per indicated horsepower........pounds..	1.84	
Speed ....knots..	11.4	

The following table gives the mean results of her thirty-hours' trial at 10,250 horsepower:

	Starboard.	Port.
Mean steam:		
In boilers .... pounds..	259	258
At engines .... do....	221	221
Mean vacuum .... inches..	27	26.2
Mean revolutions........	101.9	103.1
Mean pressure in cylinders:		
High	100	99.3
Intermediate	35.9	35.2
Low	12.1	10.9
Indicated horsepower:		
High	1,854	1,862
Intermediate	1,776	1,763
Low	1,600	1,459
Total indicated horsepower	5,230	5,084
Gross total indicated horsepower........	10,314	
Coal per indicated horsepower .... pounds..	1.63	
Speed .... knots..	16.2	

It will be noticed that the coal consumption is 1.63 pounds per indicated horsepower. This figure is interesting, as it compares exactly with the trials of the vessels of the *Majestic* class at 10,000 horsepower. The coal consumption of those vessels varied from 2 pounds to 2.25 pounds per horsepower, so that on the basis of this comparison, which is a perfectly fair one, a very large saving in coal consumption has been made by the introduction of the Belleville boilers, this being especially marked in steaming at relatively high powers.

The difficulty experienced by the engineering staff of the battleship *Ocean* during her steam trials was so serious that it became necessary to place her under the shears at the dockyard to have her machinery opened up for extensive repairs. In order to effect these it was necessary to remove a considerable part of the deck and fittings.

There is reason to believe that the Admiralty was disappointed with the new battleships of the *Canopus* class. At Devonport the *Ocean* was found to be a slower vessel than her designers estimated, and although the contractors complied with the conditions of contract, so far as engine power and economical coal consumption are concerned, the Admiralty requested the contractors to subject the vessel to another trial at 10,800 I. H. P., in order to ascertain if the logs by which the speed was measured on the first instance were at fault. The vessel was trimmed exactly as on the former trial.

The repairs and alterations delayed a further trial nearly two months, the next trial being made on October 6, with results which did not prove satisfactory. The mean results of two runs over the measured mile off the Cornish coast were:

Steam in boilers	pounds..	264
Steam at engines	do....	220
Vacuum:		
Starboard	inches..	27
Port	do....	26.6
Revolutions:		
Starboard		98.5
Port		90.4
Indicated horsepower:		
Starboard		5,223
Port		5,080
Total indicated horsepower		10,303
Speed	knots..	15.5

The engines worked smoothly, but owing to the foul condition of the hull the speed was less than was anticipated.

The *Ocean* resumed her trials on October 20 with an eight hours' full speed trial off Plymouth, thus completing the series of trials arranged for her. This trial was highly satisfactory, the indicated horsepower and speed estimated when the vessel was designed being exceeded. The mean results of the run were:

Steam in boilers	pounds..	272
Steam at engines	do....	234
Vacuum:		
Starboard	inches..	27
Port	do....	27
Revolutions:		
Starboard		112
Port		114
Indicated horsepower:		
Starboard		6,910
Port		6,918
Total indicated horsepower		13,828
Air pressure		nil.
Speed	knots..	18.5
Coal consumed, per indicated horsepower, per hour	pounds..	1.7

GOLIATH.

(Page 51, No. XV; page 174, No. XVI, Part IV.)

This battleship completed on September 30 her thirty hours' steam trial at one-fifth power, and the following were the results:

Steam in boilers	pounds..	236
Vacuum:		
Starboard	inches..	27.3
Port	do....	26.3
Revolutions:		
Starboard		65.8
Port		65.6

SHIKISHIMA. (Japanese battle ship.) 14,850 tons; I. H. P., 14,500, speed, 18.5 knots; launched 1898.

Indicated horsepower:		
Starboard		1,467
Port		1,340
Total indicated horsepower		2,807
Speed	knots	11.7
Coal consumption, per indicated horsepower, per hour	pounds	1.73

She then left Plymouth at daybreak October 5 for a thirty hours' trial at a mean indicated horsepower of 10,700, this being four-fifths of her full power. Before commencing the trial the contractors conducted a series of experiments with a new apparatus for getting rid of steam from the auxiliary engines. The new fittings proved highly satisfactory, and after they had been worked several hours the vessel was started on her thirty hours' trial. The engines worked splendidly, a mean indicated horsepower of 10,700 giving the vessel a log speed of 18 knots. Unfortunately, after three hours' steaming, minor difficulties arose in the machinery department, and at the request of the contractors the trial was abandoned in order that further adjustments might be made.

The *Goliath* held still another trial, returning to Plymouth on October 11 on completion of a thirty hours' steam trial at four-fifths full power. The mean results were:

Steam in boilers	pounds	273
Vacuum:		
Starboard	inches	26
Port	do	26.5
Revolutions:		
Starboard		99.5
Port		101
Indicated horsepower:		
Starboard		5,160
Port		5,253
Total indicated horsepower		10,413
Speed by log	knots	17.32
Coal consumption, per indicated horsepower, per hour	pounds	1.54

INVINCIBLE.

The *Invincible*, a 6,000-ton battleship, had her triennial steam trial November 1.

JAPAN.

SHIKISHIMA.

(Page 36, No. XVI, Part II; 188, No. XVI, Part IV.)

This vessel left Portsmouth on October 10 for Torbay to run an 8-knot course in deep water. The engines worked well, indicating upward of 15,000 horsepower on the measured distance, or 500 horsepower beyond the contract, and obtained a mean speed of 19.023 knots, at slightly over her load draught of 27 feet 3 inches. She turned a complete circle in three minutes sixteen seconds, heeling only 5 degrees.

RUSSIA.

POLTAVA.

This new battleship, in a twelve-hour trial trip, made 16.29 knots an hour, developing 11,000 I. H. P., instead of 10,600 required under the contract.

GERMANY.

SACHSEN.

A trial trip of the *Sachsen* took place May 1. The engine efficiency was gradually increased; during the three hours' trip under full steam the maximum efficiency attained was 5,940 I. H. P., with 96 revolutions. The air pressure was about 0.787 inch water column. With the exception of the heating of a few bearings the engines and boilers were satisfactory, and the results very favorable. The average speed on the full-speed run was 14.5 knots. Boilers, water tube of the Dürr type.

KAISER FRIEDRICH III.

At her forced-draft trial the engines developed 13,500 I. H. P., or 500 more than required by the contract, making 115 revolutions, and giving 18 knots speed, although there was a heavy sea running at the time.

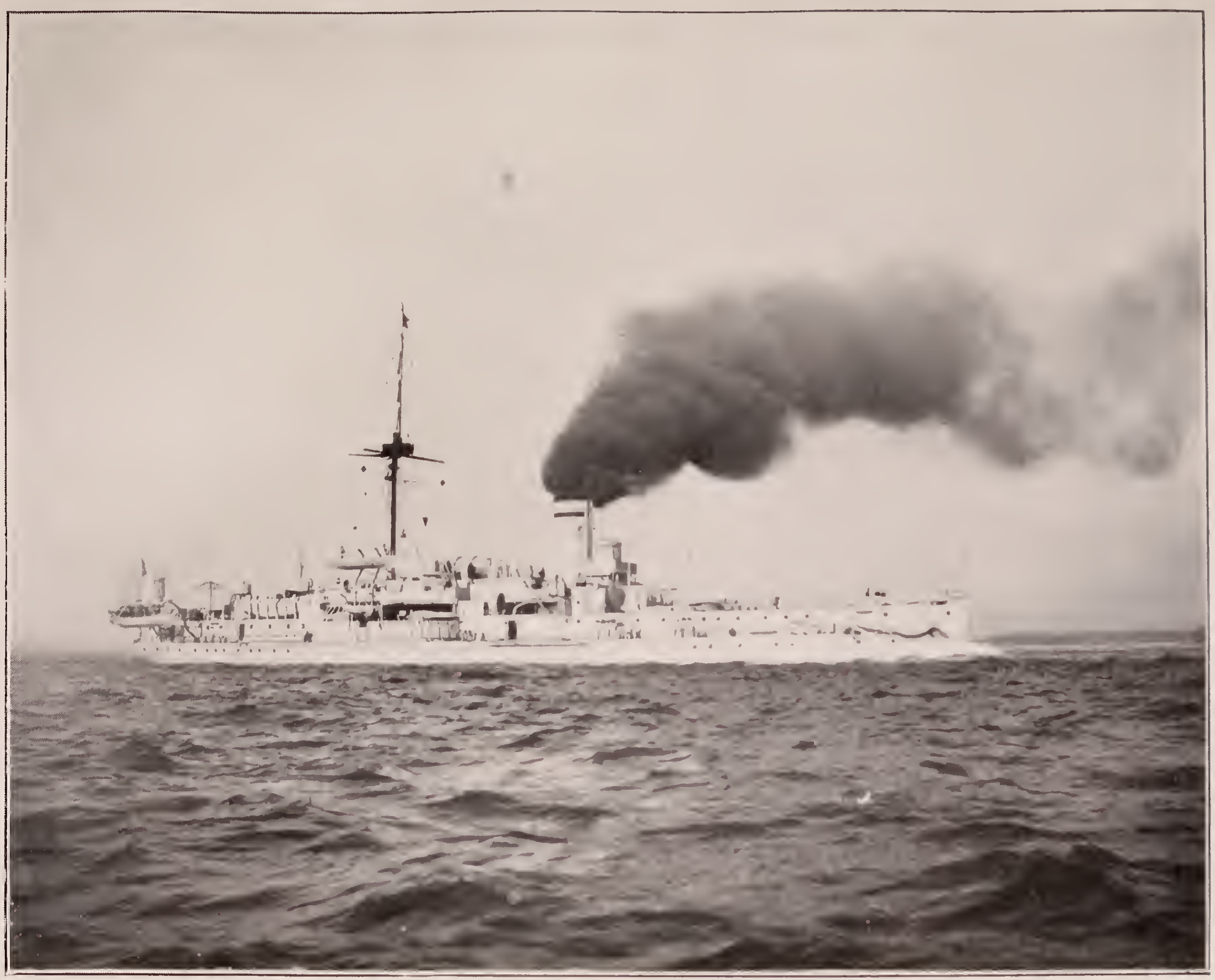
Cruisers.

ENGLAND.

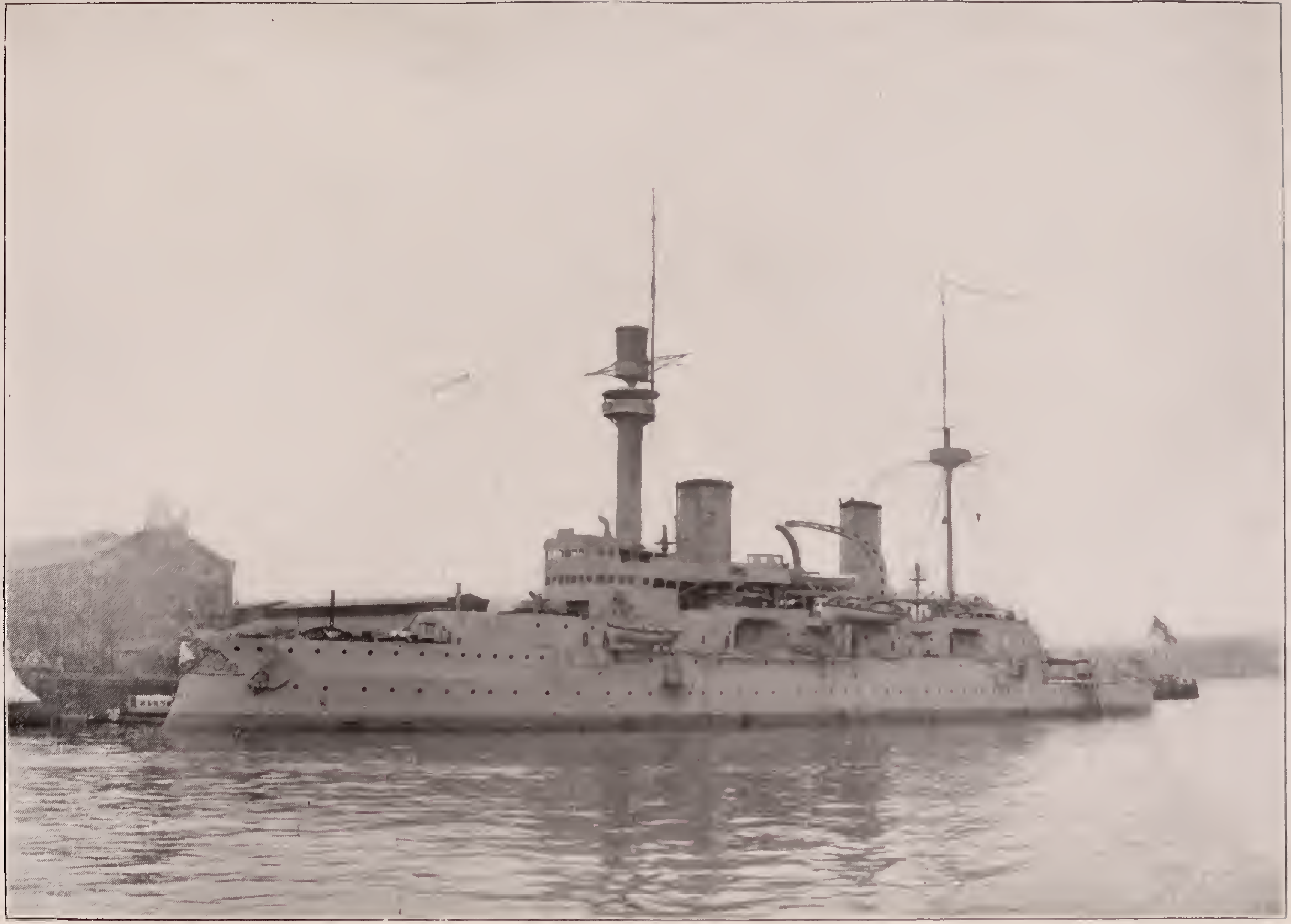
AMPHITRITE.

(See page 51, No. XV; 32, No. XVI, Part II.)

The first-class cruiser *Amphitrite*, of 11,000 tons and 18,000 indicated horsepower, built and engined by Messrs. Vickers, Sons & Maxim, Limited, Barrow-in-Furness, underwent a series of steam trials in the English Channel, and these trials are specially interesting in view of the fact that arrangements have been improvised so that the exhaust from the auxiliary machinery may be utilized for making up the feed instead of being passed direct into the condenser. It was at one time intended to use the exhaust from the feed pumps to drive the circulating pump engine, and subsequently for making up the feed; but the time available before the date fixed for the trials did not permit of the necessary alterations being made for both purposes. On the pipe between the auxiliaries and the condenser a loaded valve of the piston type was fitted to get a constant pressure in the exhaust pipe, which of course acted as a receiver, and the necessary connections were made from it to the evaporator. It was not considered desirable to subject the auxiliary engines to a higher back pressure than 20 to 25 pounds—the pipes are tested to 50 pounds—and it was for this pressure that all the arrangements were made.



SACHSEN (German battle ship.) 7,441 tons; I. H. P., 4,917; speed, 14 knots; launched 1877. Showing appearance since being reconstructed.



KAISER FRIEDRICH III. (German battle ship.) 11,180 tons; I. H. P., 13,000, speed, 18 knots; launched 1896.

On the 3,600 indicated horsepower trial it was found impossible to maintain this pressure in the pipe receiver, as the only engines exhausting into it were two of Weir's feed pumps, working at little more than 3 strokes per minute, and the fire and bilge pumps. The spring of the valve was therefore set at about 8-pound load. Neither fans nor compressed-air blowing engines were in use in the stokehold at the low-power trial. Under these circumstances the experiment was discontinued after two hours, as it was found that the receiver pressure could only be maintained at 7 pounds, and as little steam was passing to the evaporator, the loss in the feed water—a little over 1 ton per hour—was not being made up. As measured at the feed tanks, the "make-up" was only slightly over one-fourth ton per hour. Of course the deficiency had subsequently to be made up, as it is a condition in the case of all naval steam trials that the loss during a trial must be made good, so that the reserve feed at the end will at least equal that at the beginning. Excepting about one-half ton, therefore, the loss in the thirty hours' trial was made up by using steam taken direct from the boiler, although for a considerable period the evaporators, as on some previous trials, were worked on the compound system, the steam passing at the point of exhaust from the one to the other of the two evaporators in the ship.

On the thirty hours' trial at 13,500 I. H. P. it is proposed to load the valve of the pipe receiver to at least 20 pounds, but we must defer further reference to this matter until the test is over. It may be said, however, that with the great supply of steam from the larger number of auxiliary engines in use, there can be no doubt that the experience gained will be an invaluable aid to the solution of the problems associated with the large steam consumption of auxiliary machinery, a defect which Sir John Durston, with commendable energy, has determined to overcome.

As to the results of the 3,600 I. H. P. steaming trials, as given in the appended table, they must be pronounced as very satisfactory. The coal consumption—1.54 pounds per I. H. P. per hour—is the lowest recorded in any trial with water-tube boilers. The fuel was certainly of good quality, the strong wind insuring good draft was an advantageous element, the system of stoking regularly and moderately was perfect; but, in addition, it must be said that the engines worked very sweetly, the adjustments being excellent, while care was taken to insure that the circulating water did not "drown" the small quantity of steam passing through the condenser, so that the feed was maintained at a fair temperature. Again, the boiler casings fitted well—a point not always attended to—and the pipes were more extensively lagged than in the *Diadem* class, there being 18 instead of 6 tons of the coating material, so that the loss from radiation was minimized. The cylinder jackets were not used.

The power was very steady, with noticeable uniformity as between port and starboard engines, while it was arranged that the high, the intermediate, and the two low-pressure cylinders combined would give equal proportions of power. The engines were set to cut off at about 30 per cent of the stroke, the links being run full in. We give * * * the mean results in tabular form, and although we have described the *Amphitrite*, *Argonaut*, and *Ariadne*, all vessels of the same class (*see* Engineering, Vol. LXVI, p. 830), we may say that the engines have four cylinders—one of 34 inches, one of 55½ inches, and two of 64 inches diameter by 48 inches stroke. The high-pressure and intermediate are placed as closely together as possible, the cranks being opposite, while the two low-pressures similarly balance each other. The propellers are 17 feet in diameter, 21 feet pitch, with 63 square feet of developed blade surface in each. There are 30 Belleville boilers, the total heating surface in the tubes being 32,375 square feet and in the econmizer tubes 15,505 square feet, a total of 47,880 square feet, while the grate area is 1,390 square feet, the ratio being 1 to 34.4 of heating surface.

Date of trial	April 8 and 9, 1899.
Nature of trial	thirty hours' coal consumption at 3,600 I. H. P.
Draught of water:	
Forward	24 feet 9 inches.
Aft	26 feet 6 inches.
Speed of ship:	
By log	12.8 knots per hour.
At measured distance run	13.32 knots.
Steam pressure:	
In boilers	226 pounds per square inch.
At engines	212 starboard, 212 port.

	Starboard.	Port.
Vacuum in condensers ... inches	26.3	26.9
Revolutions per minute	73.0	72.1
Mean pressure in receivers:		
High ... pounds	134	138
Intermediate ... do.	33	34
Low ... do.	1.5	1.8
Mean pressure in cylinders:		
High ... pounds	38.7	35.8
Intermdediate ... do.	15.0	15.9
Forward low ... do.	5.56	5.46
Aft low ... do.	5.59	5.38
Mean indicated horsepower:		
High	621	568
Intermediate	643	674
Forward low	317	308
Aft low	318	302
Total	1,899	1,852
Grand total	3,751	
Consumption of coal per indicated horsepower per hour ... pounds	1.54	
Total ... do.	173,324	

On the 3,600 I. H. P. trial, however, only twelve boilers were in use, those nearest the engines, and in view of the economy it may be said that the grate area in use totaled 588 square feet, so that the horsepower equaled 6.37 per square foot of grate and the coal burned was 9.84 pounds per square foot of grate per hour.

* * * We append a table giving the chief data relating to the particular hour of the trial during which these indicator diagrams were taken.

April 9, 1899, twentieth hour, 6.30 a. m.

	Starboard.	Port.
Mean steam in boilers	217	
Mean steam at engines:		
Reduced ... pounds..	210	210
High-pressure receiver ... do....	133	133
Mean vacuum ... inches..	26.4	27.0
Mean revolutions	74.0	72.3
Mean pressure in cylinders:		
High ... pounds..	37.8	34.3
Intermediate ... do....	15.0	15.0
Low forward ... do....	5.6	5.2
Low aft ... do....	5.5	5.1
Total coal burned for hour ... pounds..	5,520	
Indicated horsepower:		
High	616	545
Intermediate	650	635
Low forward	323	293
Low aft	317	287
Total indicated horsepower	1,906	1,760
Gross total indicated horsepower		3,666
Mean coal per indicated horsepower for hour		1.5

The *Amphitrite*, which was under the command of Capt. G. L. Atkinson, captain of the Chatham steam reserve, steamed out of the Medway on Saturday morning, having been delayed a day owing to the gale, and anchored in Plymouth Sound on Sunday evening. During the greater part of the time she experienced a strong head wind, which accounts for the log speed being 12.8 knots. On Sunday morning Commander Rollston took records of the speed on two runs over the measured deep-sea course between Rame Head and the Dodman. The weather conditions were suitable. There was a westerly wind of force 2. On the first run, with this breeze dead against the ship, this distance was covered in one hour forty-two minutes seven seconds, equal to 13.51 knots; but there was a slight current with the ship. On the return run, with the wind but against the current, the time was one hour forty-five minutes, equal to 13.14 knots, a mean of 13.32 knots, which agrees with the speed on the other ships of the class under similar conditions.

With the trials at 13,500 and 18,000 I. H. P. we intend to deal at length in a subsequent issue.—[*Engineering, April 14, 1899.*]

The *Amphitrite* completed her contract trials in the English Channel on Monday evening last, returning to Chatham next morning. We dealt last week with the results of the first trial at 3,600 I. H. P., equal to one-fifth the total, and during the subsequent trials of the vessel the success first achieved was repeated. The coal consumption on the 13,500 I. H. P. or maximum continuous steaming trial, was only 1.43 pounds per I. H. P. per hour, which is the lowest point yet touched by a vessel with water-tube boilers, and we have no such record result taken with corresponding exactitude in a merchant steamer. The rate of consumption never varied much; only two of the hourly "chits," as they are called on board, noted a higher rate than 1½ pounds—one 1.55 pounds and another 1.51 pounds. The stoking was done systematically and intelligently, with the minimum of coal and the maximum of distribution over the grate, and an arrangement was made whereby a door was not opened at more frequent intervals than six and one-half minutes. Again, in "clinkering" the fires, the great bugbear of the engineer, only one-third of a grate was cleaned at a time, and the work in a stokehold with eight boilers was equally distributed over a watch.

The same system obtained on the full-power trial, but instead of the interval between stoking through each fire door being about six and one-half minutes, it was reduced to five and one-half minutes, and the proportion of coal increased; but, as Lieutenant Norton, of the United States Navy, said at the Institution of Naval Architects, when full power is wanted in action no one cares what the consumption is. However, there is no reason why the *Amphitrite*, or any of the ships of the class, should not repeat their trial performance as regards coal consumption as well as power. Experience on board a succession of ships leads us to commend the steady improvement in the stoking. The men are "tumbling" to the requirements of the large grate boiler as a consequence of their training. On the full-power trial of the *Amphitrite* the consumption was 1.57 pounds per I. H. P., which must be pronounced a favorable result. As a matter of fact she traveled at the rate of 518 nautical miles per day of twenty-four hours for a total consumption of 305 tons. This for 11,000 tons' displacement of ship is undoubtedly satisfactory.

An interesting point was that no compressed-air blowing engines were used throughout the trials, and, judging from the results obtained, it seems that if sufficient attention is given to the firing blowing engines for supplying air jets in the furnaces are not necessary, saving steam, and weight and space in the stokeholds. This economy, too, has been partly confirmed in the evaporation trials on shore. Moreover, on the full-power trial only were the fans for supplying air to the stokeholds run, and even then they made but 100 revolutions or so per minute during the first four and one-half hours, and about 150 revolutions in the remaining three and one-half hours, when also the stokeholds were closed down; but no perceptible air pressure was produced. The diameter of the fans is 6 feet 6 inches. It is true that on the 13,500 I. H. P. run, the wind was of considerable force during the greater part of the trial, affording good draft.

In view of the economy which was attained, it may be stated that on the 3,600 I. H. P. trial the auxiliary engines at work included the following: Two main circulating engines, one electric-light engine, two main feed pumps (the one averaging four to six double strokes per minute, and the other nine strokes), and two auxiliary circulating pumps, all for the thirty hours. One of the hot-well pumps was worked for thirty hours, the other for three and one-half hours, there being a cross connection between the two; an evaporator pump was run for eighteen and another for twenty-one hours, while one fire and bilge pump was used for fifteen hours, a second for twenty, and a third for thirty hours, and the steering engines and ash hoists were, of course, worked as required. On the thirty hours' 13,500 I. H. P. trial the two main circulating, the electric engine, two auxilary circulating, and two hot-well pumps were worked throughout; while the four main feed pumps were on for twenty-one hours, and the auxiliary feed pumps during the remainder of the trial, it being the Admiralty practice to run part of the trial with the main and part with the auxiliary pumps to test both. One evaporator was worked for twenty-three hours, and another for fifteen hours. The four fire and bilge pumps were worked for twenty hours on an average. Two fans were tried for two hours at 90 revolutions. On the full-power trial all the fifteen auxiliary engines named were at work along with the eight fans.

As to the main propelling engines, they worked beautifully. The cut-offs in the 13,500 indicated horse-power trial were at 64 per cent in the high-pressure, 65 per cent in the intermediate, and 70 per cent in the two low-pressure cylinders. On the full-power trial the cut-off in the high-pressure cylinder was at 66 per cent of the stroke. It will be seen that the setting was arranged so that the high, intermediate and the two low-pressure cylinders together would give as near as possible the same proportion of power. The object of this arrangement is to insure a lower range of pressure and temperature in the low-pressure cylinder and thus to reduce condensation. On each trial the feed-water reserve had to be made up to the same level as at the beginning. On the low-power trial the effect of the working of the evaporators with steam taken direct from the boilers was marked, the rate of consumption going up about 0.15 pound per horsepower hour. Two tons of distilled water per hour were then being made. As to the use of the exhaust of the auxiliary machinery for the evaporators, reference is made to it in another article in the present issue on the consumption of steam in auxiliary engines on warships, in connection with corresponding trials in the *Vindictive.* The main purpose of the *Amphitrite's* trials was to conform to the specification, and the improvised and somewhat hastily prepared arrangements for the extra test somewhat affected the success of the experiment.

No trouble was experienced with the boilers. After the thirty hours' trial at 13,500 indicated horsepower, it was found that one square feed collector, which extends across the front of the boiler at the bottom of the elements of tubes, was slightly laminated; but we mention this only to show with what facility repairs or changes can be effected in the boilers. There was a spare feed collector, and it was substituted for the other, partly while the vessel was doing her gun and circle trials. Several of the fusible plugs fitted in the junction boxes of the elements came out during the full-power trial, probably due to the diameter being rather large.

The appended table gives the mean results, including pressures in the receivers and cylinders, as well as the powers, for both 13,500 indicated horsepower and full power trials. Corresponding results for the 3,600 indicated horsepower were given in last week's issue. On the first-named trial the power varied from 13,169 to 14,085, and at the eight hours' trial from 18,062, the rate for the first two hours, to 18,443 indicated horsepower, the aim being not to exceed the designed rate to any great extent.

	First trial.	Second trial.
Date of trial	April 12 and 13, 1899	April 17, 1899.
Nature of trial	30 hours' coal consumption at 13,500 I. H. P.	8 hours' full power at 18,000 I.H.P.
Draught of water:		
Forward	24 feet 3 inches	24 feet 3 inches.
Aft	26 feet 3 inches	26 feet 3 inches.
Speed of ship, nautical miles per hour.	19.73 on measured course; 19.52 by log.	20.78 mean of four runs; 20.94 by log.
Steam pressure in boilers	252 pounds per square inch; reduced steam, 240 pounds.	279 pounds per square inch; reduced steam, 254 pounds.
Air pressure in stoke holds	Nil	Nil.

	First trial.		Second trial.	
	Starboard.	Port.	Starboard.	Port.
Vacuum in condensers........inches..	25.8	26.2	26.2	26.2
Revolutions per minute........	111.6	110.6	122.4	121.2
Mean pressure in receivers:				
High........pounds..	233	231	246	243
Intermediate........do....	77	76	87	91
Low........do....	13.2	11.5	18	18
Mean pressure in cylinders:				
High........pounds..	89.8	89.2	103.0	102.6
Intermediate........do....	36.2	36.4	44.0	44.3
Forward low........do....	13.2	13.1	17.2	16.6
Aft low........do....	13.5	13.2	16.8	17.0
Mean indicated horsepower:				
High........	2,208	2,174	2,770	2,736
Intermediate........	2,364	2,355	3,155	3,147
Forward low........	1,149	1,130	1,638	1,569
Aft low........	1,177	1,138	1,608	1,606
Total........	6,898	6,797	9,171	9,058
Grand total........	13,695		18,229	
Consumption of coal:				
Per indicated horsepower per hour........pounds..	1.43		1.57	
Total........do....	587,760		228,360	

The total weight of machinery complete is 1,550 tons, and of boilers 757 tons, and it may be interesting to note that on the full-power run the power developed was equal to 24 units per ton of boilers, and to 11.7 I. H. P. per ton of machinery. The fuel consumption was at the rate of 19.8 pounds per square foot of grate, and the power developed equaled 13.1 per square foot of grate, while the heating surface per unit of power is 2.62 square feet. It may be added that on the occasion of evaporative trials on shore with two of the boilers the coal burnt per square foot of grate was at the rate of 30.38 pounds per hour, and the water evaporated 9.37 pounds, the equivalent evaporation per pound of coal from and at 212° F. being 11.45 pounds. The steam pressure was 300 pounds. This trial was of four hours' duration.

We supplement our record of means by the subjoined table giving the hourly records on the eight hours' full-power trial, the results showing the remarkable uniformity of the running of the main engines. It will be noticed that the variations between the starboard and port are almost within the limits of error. The coal consumption, as was to be expected, was rather high at the beginning of the trial; the men had not quite settled down to their work. It should also be stated that the evaporators made a large volume of water during the trial.

Hourly records on eight hours' full-power trial.

	Steam pressure.	Revolutions.		Indicated horsepower.			Consumption of coal.	
		Starboard.	Port.	Starboard.	Port.	Total.	Per hour.	Per I. H. P. for hour.
	Pounds.						*Pounds.*	*Pounds.*
1	279	120.8	120.6	9,033	9,029	18,062	31,680	1.75
2	280	121.4	120.9	9,032	9,030	18,062	32,640	1.81
3	282	122.1	120.8	9,162	8,951	18,113	29,040	1.60
4	280	123.0	121.4	9,286	9,022	18,308	26,640	1.46
5	277	122.3	120.9	9,181	9,152	18,333	28,080	1.53
6	276	123.6	122.0	9,318	9,125	18,443	29,520	1.60
7	280	122.6	121.1	9,169	9,095	18,264	29,040	1.59
8	277	123.2	121.9	9,186	9,063	18,249	21,720	1.19
Mean	279	122.4	121.2	9,171	9,058	18,229	28,545	1.57

Stopping, starting, and reversing trials were made on Saturday. With the steam gear the time taken from full speed ahead to stop was thirty-nine seconds with the starboard and twenty seconds with the port engine; from stop to full speed astern eight seconds and ten seconds, respectively, and from full speed astern to full speed ahead ten seconds with each engine. With the hand gear both engines were stopped in one minute thirty-six seconds, and the complete change from astern to ahead was made in sixty-five seconds. The reversing gear is slightly different to that fitted in the *Niobe*, and is much more rapid in its action. In addition to that, on account of the defects which have been reported in connection with the working of the *Niobe*, the pipes supplying the receivers from the starting valves have been considerably increased in size. A series of trials was made in the *Amphitrite* with the engines in almost every possible position, and with the vacuum in the condenser purposely broken, in order to test the facility of handling. So far as could be ascertained during the trials, extending over two hours, there was no position in which the engines would not start almost immediately, either ahead or astern, as required.

As to the speed of the ship, eight runs were made over the measured course between Dodman and Rame Head. On the 12th instant the weather conditions were most unfavorable, as will be seen by the results in the table appended. Although the revolutions on the four runs varied little, there was a great difference in the speeds recorded, and consequently in the slip of the propeller. There was a southwesterly wind, which steadily increased in violence, unduly increasing the third, and decreasing the fourth run, when the wind was of force 6, so that the slip was high. Running 120 miles beyond the Scilly Isles, when a heavy sea and a high wind shook the ship up a bit, a young shark about 3 feet long came aboard with one of the seas over the forecastle. On the 13th instant the ship again ran the measured course, although the weather conditions were not much better; but, for less revolutions than on the preceding day, the speed was 19.73 knots instead of 19.55 knots. The wind was from the NNW., and on the first two runs was of force 2, and on the third and fourth of force 4.

Speed trials over the 23-knot measured course.

APRIL 12, 1899 (13,500 I. H. P.).

Number of run.	Time for 23 miles.	Course.	Revolutions per minute (mean).	Speed.	Slip.
	Min. sec.			*Knots.*	*Per ct.*
1	72 4	Dodman to Rame Head	112.4	19.15	17.8
2	70 24	Rame Head to Dodman	112.5	19.60	16
3	69 1	Dodman to Rame Head	112.9	20	14.6
4	74 47	Rame Head to Dodman	112.2	18.45	20.7
		Mean of means	112.5	19.55	16.2

APRIL 13, 1899 (13,500 I. H. P.).

Number of run.	Time for 23 miles.	Course.	Revolutions per minute (mean).	Speed.	Slip.
5	72 48	Dodman to Rame Head	111.4	18.95	18
6	67 50	Rame Head to Dodman	113.5	20.34	13.6
7	70 42	Dodman to Rame Head	113.2	19.52	16.9
8	71 28	Rame Head to Dodman	111.4	19.30	16.5
		Mean of means	112.1	19.73	15.2

Mean of mean speed—	Knots.
For Nos. 1 to 4	19.55
For Nos. 5 to 8	19.73
For Nos. 1 to 8	19.64

APRIL 17, 1899 (FULL POWER).

Number of run.	Time for 23 miles.	Course.	Revolutions per minute (mean).	Speed.	Slip.
	Min. sec.			*Knots.*	*Per ct.*
1	67 41	Rame Head to Dodman	121	20.39	18.8
2	65 46	Dodman to Rame Head	122.6	20.98	17.5
3	66 46	Rame Head to Dodman	121.9	20.67	18.3
4	66 1	Dodman to Rame Head	122.7	20.9	17.9
		Mean of means	122.1	20.78	18

On the full-power trial the same course was run four times under favorable weather conditions, the sea being calm, with a genial sunshine. On the first and third runs the southwest wind blowing (force 2 to 3) was against the ship, and on the first run there was also a slight current against the vessel. The mean speed recorded, it will be seen, is almost exactly that anticipated by the design, 20.75 knots for 18,000 I. H. P. The 20.78 knots was got with a mean of about 18,280 I. H. P.—[*Engineering*, *April 21*, *1899*.]

ARIADNE (11,000 TONS AND 18,000 I. H. P.).

Built and engined by the Clydebank Engineering and Shipbuilding Company, Limited.

	30 hours' coal consumption at 3,600 I. H. P.	30 hours' coal consumption at 13,500 I. H. P.	8 hours' full power.
When tried	Jan. 31 and Feb. 1, 1899.	Feb. 3 and 4, 1899	Feb. 6, 1899.
Draught of water:			
Forward	25 feet 5 inches	24 feet 8½ inches	24 feet 3 inches.
Aft	26 feet 2 inches	25 feet 11½ inches	26 feet 3 inches.
Actual load on safety valves...pounds	300	300	300
Pressure of air in stokehold, inches of water	......	......	0.23 inches.
Average pressure:			
At boilers	218	262	288
At engines	202	227	240
Receiver pressures:			
High pressure	143.5	206.5	229
Intermediate pressure	34.5	58.5	75.5
Low pressure	5	18	24.5
Average vacuum	24.8	25.5	25.3
Mean pressure in cylinders:			
High pressure	20.6 17.7	84.2 87.5	103.4 104.7
Intermediate pressure	17.3 18.1	32.9 33.1	40.3 41.9
Low pressure, forward	7.8 8.3	16.3 16.7	21.3 21 1
Low pressure, aft	7.6 7.3	17.4 16.4	22.6 20.9
Mean number of revolutions per minute	70.3	109.1	118.9
Indicated horsepower, total	3,758	14,046	19,156
Speed...knots	13.3	20.1	21.5
Force of wind	2 to 3	1 to 6	2 to 3
State of sea	Slight swell	Smooth to moderate	Moderate swell.
Propeller:			
Diameter	17 feet.		
Pitch	21 feet 6 inches	21 feet 6 inches	21 feet 6 inches.
Consumption per I. H. P. per hour	2.05	1.73	1.66

The speeds attained by the sister ship *Argonaut* at her four-fifths-power trial, on November 29–30, 1898; full-power trial, December 3, and one-fifth-power trial, December 12, 1898, were respectively as follows: 19.94 knots, 21.14 knots, and 13.16 knots.

HERMES AND HIGHFLYER.

(Page 51, No. XV; 32, No. XVI, Part II; 175, No. XVI, Part IV.)

The *Hermes* completed her trials on June 13, and the *Highflyer* ran her official trials between June 20 and 30. Both ships are identical. The principal dimensions are: Length between perpendiculars, 350 feet; breadth, extreme, 54 feet; displacement, 5,600 tons. There is a cellular bottom extending the full length of the engine and boiler spaces, and before and abaft these the water-tight flats of the magazines, etc., continue the double bottom right to the stem and stern. Under the protective deck the side compartments for the full length of the boiler space are utilized for stowing coal. The hull is subdivided by longitudinal and transverse bulkheads into numerous water-tight compartments as usual, the number of water-tight doors having been reduced to a minimum, and all being worked from the main deck as well as from below. The sternposts, struts, and stem are of phosphor-bronze. The stem is of the usual ram form, and the structure behind is especially strong and efficiently connected to the general framework of the vessel with a view to the contingency of ramming. The rudder, also of phosphor-bronze, is of the balanced type and controlled by Harfield's compensating gear below the protective deck. The vessel being intended for foreign service and long cruises at sea, in which the maintenance of a uniform speed becomes essential, she has been completely covered to above the load water line with teak of a minimum thickness of 3½ inches, and coppered. To secure steadiness of gun platform, so necessary in a vessel intended for war purposes, bilge keels extending for about half the vessel's length amidships have been fitted.

The protection of the vessel consists of a curved deck extending from stem to stern, ranging from 3 inches to 1½ inches in thickness, covering the whole of the propelling and steering machinery, boilers, magazines, etc. The reserve bunkers are on the protective deck over the machinery space, and while affording a water-line belt of coal protection they, being subdivided into water-tight compartments, give additional security in the event of damage. An armored conning tower of Harveyized steel is placed forward, fitted up with the usual means of navigating the vessel and directing operations while in action, the whole of the connections for which are protected by a steel tube extending to the protective deck. The steel for this tower has been supplied by Messrs. William Beardmore & Co., Parkhead. Three search lights are operated from these bridges, and the vessel throughout is fitted with a complete installation of electric light. Her armament consists of eleven 6-inch, eight 12-pounder R. F. guns, and a number of smaller machine guns. The guns are all protected by extra-thick shields. Two submerged torpedo tubes are fitted forward, capable of working the latest pattern torpedoes.

The propelling machinery consists of two sets of triple-expansion engines, fitted in two separate engine rooms, each set having four inverted cylinders and four cranks. The high-pressure cylinders are 26 inches in diameter, the intermediate-pressure cylinders 42 inches in diameter, and each of the four low-pressure cylinders 48 inches in diameter, all adapted for a stroke of 2 feet 6 inches. The cylinders are all separate and independent castings, each fitted with a cast-iron barrel or liner and steam jacketed. Each of the high-pressure and intermediate-pressure cylinders is fitted with piston valves, and each of the low-pressure with flat slide valves, all worked by the usual double-eccentric and link-motion valve gear. The reversing engines are of the all-round type, capable of being reversed, with worm and wheel gear, all the levers being fitted with a slot and adjusting screw to allow of the expansion of steam in the cylinders being altered. The back columns are of cast iron, fitted with separate guide faces, and the front columns are of forged steel, the engines being arranged with the starting platform amidships. The condensers are of brass and placed at the wings, the steam being condensed outside the tubes. There are two centrifugal pumps of gun metal, each worked by an independent engine, one in each engine room, and arranged with a cross connection, so that either or both condensers can be supplied with cooling water from either pump.

The feed-bilge and hot-well engines are all independent and separate from the main engines. Steam is supplied by a special range of auxiliary pipes. Feed-water filters are fitted to prevent any impurities reaching the boilers. The crank, thrust, and propeller shafting is of forged steel and hollow. The crank pins are fitted with centrifugal lubricating apparatus. The propellers are of gun metal, each propeller having three adjustable blades.

Steam is supplied by 18 Belleville water-tube boilers of the latest type, fitted with economizers, and adapted for a working pressure of 300 pounds. The boilers are arranged in three boiler rooms, and there are three funnels. Fans and engines are fitted in the stokeholes to insure the necessary supply of air, air-pumping engines being also fitted to deliver air direct into the furnaces and combustion chambers.

The vessel is also fitted with the usual auxiliary machinery, viz, a complete distilling plant to supply fresh water to the boilers, and also for drinking purposes; two sets of engines and dynamos for producing the necessary current for electric lighting; one double-cylinder engine with the necessary gear for steering purposes; two complete sets of air-compressing engines and pumps, with the air reservoirs for charging torpedoes, and one refrigerating machine of the cold-air type, with the necessary cold chamber for ships' provisions. The exhaust steam from all of the auxiliary engines in the machinery room, including the steering engines, can be utilized for evaporation or other uses.

Since the first trial, the vessel has made two runs, one at low power, because on the former occasion the conditions did not admit of reliable results being realized; and, as will be seen from the table of results appended, the coal consumption was greatly reduced, being 1.78 pounds. The second supplementary trial was run at 9,000 indicated horsepower, with the exhaust steam from the auxiliary machinery passing into the low-pressure receiver of the propelling engines—an arrangement which gave satisfaction.

Mean results of additional trials of H. M. S. Hermes.

[Built and engined by the Fairfield Shipbuilding and Engineering Company, Limited, Glasgow.]

	Second 30 hours' 2,000 I. H. P. coal-consumption trial.		Eight hours' trial at 9,000 I. H. P., with auxiliary machinery exhaust steam passing to the low-pressure receivers of main engines.	
Date of trial	June 9 and 10, 1899.		June 13, 1899.	
Mean steam:				
In boilers ...pounds..	196		270	
At engines ...do....	126		247	
	Starboard.	*Port.*	*Starboard.*	*Port.*
Mean cut-off in high-pressure cylinder ...per cent..	35	32.7	56	56
Mean vacuum ...inches..	26	27	25.1	25.2
Mean revolutions ...per minute..	111.2	110.6	174.4	176.8
Mean pressure in cylinders:				
High ...pounds..	40.2	35	105	96.6
Intermediate ...do....	16.1	15.9	31.2	31.7
Low forward ...do....	6.86	6.21	23	21.8
Low aft ...do....	5.78	5.47	19.5	19.6
Indicated horsepower:				
High	360	312	1,470	1,374
Intermediate	377	362	1,143	1,176
Low forward	209	189	1,099	1,058
Low aft	176	166	934	949
Gross total indicated horsepower	2,151		9,203	
Coal per indicated horsepower, per hour ...pounds..	1.78		1.52	
Speed per hour ...knots..	13.4		20	

The *Highflyer* trials gave even more satisfactory results, the coal consumption being unprecedentedly low on the full-power run, when the boiler pressure was maintained at 292 pounds, and at the engines the mean was 228 pounds. The links were set to cut off at 74 per cent of the stroke, and the starboard engine, running at 187.6 revolutions, made 5,262 horsepower. The port engine ran at 186.5 revolutions. It will be noticed from the table that the power got from the high and intermediate cylinders is almost equal, while the powers of the low-pressure cylinders also closely approximate each other. The variation is practically within the limits of error. This same remark holds good as regards the other trials, the low-pressure cylinders each giving about 66 per cent of the power indicated in each of the high and intermediate. This arrangement gave most satisfactory results as regards engine balancing, there being practically no vibration. The collective power on this trial was 10,344 horsepower. The speed of the ship was 20.1 knots, which more than meets the expectations of the design. On the thirty hours' trial, at continuous sea speed, the steam pressure was 260 pounds, and at the engines it was reduced to 223 pounds. The cut-off was arranged at 56 per cent of the stroke, and at

169.7 revolutions the starboard engine gave 3,828 horsepower, while the port engine recorded 3,816 for 168.1 revolutions. The collective power was thus 7,644 indicated, while the speed of the ship was 19.4 knots. The addition, therefore, of 2,700 indicated horsepower to the power, equal to 34 per cent, barely added three-fourths of a mile to the distance run in each hour. This 19½ knots speed was got for an expenditure of 5 tons of coal per hour, which, in view of the displacement—5,600 tons—is a very satisfactory result, proclaiming not only a high mechanical efficiency, but a beautiful form of ship and great propulsive efficiency. On the low-power trial it was preferred to work the boilers at a high pressure, reducing it greatly at the engines and cut-off steam in the cylinders at a comparatively late period of the stroke rather than with a high initial pressure and an early cut-off. The steam pressure was, at the boilers, 214 pounds, and at the engines 125 pounds, this latter enabling the simple auxiliary engines to be worked at a better economy.

Mean results of trials of H. M. S. Highflyer.

[Built and engined by the Fairfield Shipbuilding and Engineering Company, Limited, Glasgow.]

	Contractors' 30 hours' 2,000 I. H. P. coal consumption trial.		Contractors' 30 hours' 7,500 I. H. P. coal consumption trial.		Contractors' 8 hours' full-power trial at 10,000 I. H. P.	
Date of trial	June 20 and 21, 1899		June 22 and 23, 1899		June 27, 1899	
Mean steam :						
In boilers ....pounds..	214		260		292	
At engines ....do....	125		223		228	
Mean cut-off in high-pressure cylinders, ...per cent..	34		56		74	
	Starboard.	*Port.*	*Starboard.*	*Port.*	*Starboard.*	*Port.*
Mean vacuum ....inches..	26.5	26	25.4	26.1	25.6	25.4
Mean revolutions	110.1	110.4	169.7	168.1	187.6	186.6
Indicated horsepower :						
High	346	320	1,313	1,265	1,610	1,523
Intermediate	341	360	1,087	1,157	1,515	1,513
Low forward	202	191	724	719	1,067	1,040
Low aft	190	185	704	675	1,070	1,006
Gross total indicated horsepower	2,135		7,644		10,344	
Coal per indicated horsepower per hour ....pounds..	1.62		1.49		1.407	
Speed per hour ....knots..	12.5		19.4		20.1	

—[*Engineering, July 7, 1899.*]

CRUISERS, SECOND CLASS.

ENGLAND.

GLADIATOR.

(Page 35, No. XIV.)

This vessel completed her thirty-hours' coal-consumption trial at one-fifth power on February 2. The vessel carries 18 Belleville boilers, not fitted with economizers, and the mean horsepower developed was 2,164, yielding a mean speed of 11.8 knots, the coal consumption being 2.16 pounds per unit of power. The vessel had not been docked since the preceding summer, and her bottom was therefore somewhat foul, else she would probably have come up to the 12.5 knots attained by the sister ship *Arrogant* at 2,157 H. P. The draught forward was 20 feet 1 inch, and 22 feet 1 inch aft. The vacuum was 26.8 inches starboard and 26.7 inches port. The revolutions were 80.5 a minute. Although cold, the weather was favorable for trial.

The second coal-consumption trial of thirty hours' duration, at three-fifths power, was run on the 12th; but after twenty-eight hours the force of the wind necessitated easing down. The trial gave a mean speed of 17.5 knots with 7,149 H. P., and a coal consumption of 1.99 pounds per I. H. P. per hour. The similar trial with the *Arrogant* gave 17.8 knots for an expenditure of 7,624 H. P. The number of revolutions per minute was 124.

On February 27, off Portsmouth, with fine weather, the eight-hours' full-power trial was successfully carried out. Owing to the foul bottom the speed was inferior to that anticipated. The mean revolutions was 137.4, the total horsepower 10,088, and the speed, by patent log, 19.1 knots.

FOX.

(Page 41, No. XIV.)

This 4,360-ton cruiser, second class, at her paying-off trial at Portsmouth, June 15, realized a speed of 17 knots. Previously, on her passage home from the cape, she maintained a regular speed of 12.8 knots, which proved her most economical rate. Her contract speed at natural draft was 18; at forced draft, 20 knots.

PIQUE.

The second-class cruiser *Pique*, of 3,600 tons, which was refitted at Devonport at a cost of £10,000, completed her trials in May. The *Pique* was built in 1889–90, and although she has since served a commission on the China station, and has twice taken part in the naval manœuvres, she is still able to steam at the same rate of speed as was attained when she ran her contractors' trials, off Plymouth, nearly ten years ago. The trials in May included one of two hours at full natural-draft power, when the mean results recorded were: Steam, 146 pounds; vacuum, starboard 28 inches, port 28.5; revolutions, starboard 127, port 127; I. H. P., starboard 3,697, port 3,496; total, 7,193; air pressure, 0.45 inch; speed, 18.5 knots.

PIONEER.

(Page 17, No. XVII, Part I.)

The *Pioneer*, a third-class cruiser, built at the Chatham Dock-Yard, and fitted with twin sets of triple-expansion engines and Thornycroft water-tube boilers by the Fairfield Shipbuilding and Engineering Company, Glasgow, has completed her contract trials. The *Pioneer* is 305 feet long, 37 feet beam, and draws 12 feet forward and 15 feet aft for a displacement of 2,215 tons. She has a heavy armament for her size—eight 4-inch rapid-fire guns, eight 3-pounders, and three Maxims, while their protective deck is effective. The main engines are of the triple-expansion type, with four cylinders arranged and proportioned in their working parts on the Schlick-Yarrow-Tweedy system, which gave most satisfactory results as to steadiness. The coal-consumption trial of thirty hours' duration was at half power instead of at one-fifth power, as in larger cruisers. In this case it was, therefore, 3,500 I. H. P.; but as a matter of fact the mean worked out to 3,665 I. H. P. for 205 revolutions, while the rate of coal consumption was 2.2 pounds per horsepower per hour. It may here be said that the average result for several vessels of the same class already tried was 2.27 pounds per horsepower per hour, the average power being 3,628 for 171 revolutions. All the eight boilers were in use. This trial took place on August 31, and the official results are as follows: Mean steam in boilers, 247 pounds; vacuum in condensers, 25.75; mean revolutions, 205.8 per minute; speed by log, 16.3 knots; speed for six special runs, 17.58 knots.

On the eight-hour trial on September 2, at what is known in the service as continuous steaming power, 5,000 I. H. P., the vessel made six runs on the measured mile at Maplin Sands, and it was found that the speed was 17.6 knots, while the mean power for the eight hours was 5,263 I. H. P. Of this the starboard engine, running at 235.5 revolutions, gave 2,638 I. H. P., and the port engine, making 234.7 revolutions, developed 2,625 I. H. P. The vacuum on the starboard engine was 24.9 inches, and on the port 25.1 inches, the pressure at the boilers being 262 pounds, and at the engines 245 pounds.

At the full-power trial on September 4 the speed of 20 knots was easily attained. Everything went well, the boilers maintaining a steady pressure at 262 pounds per square inch. The starboard engine ran at an average of 264.5 revolutions, the high-pressure cylinder recording a mean of 1,006 I. H. P., the intermediate 1,164, and the two low pressures 1,364, a total of 3,566 I. H. P. The port engine made 264.9 revolutions for a total of 3,626 I. H. P., made up of 1,143 in the high pressure, 1,156 in the intermediate, and 1,327 in the two low-pressure cylinders. The collective power, as already indicated, was 7,192 I. H. P. The vacuum on the starboard engine was 23.6 inches and on the port 23.6 inches. It may be interesting to compare the results with those got with the preceding vessels of the class. The average got was 7,152 I. H. P., the highest 7,304 I. H. P., while the average number of revolutions was 218.

DATA OF TRIALS OF VESSELS OF PIONEER CLASS.

These vessels include eleven of very similar construction. Of the six which have held trials in the course of the year, five are alike, and their dimensions, displacement, contract draught, and speed are as follows:

Length, 300 feet; beam, 36 feet 6 inches; mean load draught, 13 feet 6 inches; displacement, 2,135 tons; contract forced-draft I. H. P., 7,000, giving a speed of 20 knots; natural-draft I. H. P., 5,000, giving a speed of 18.5 knots.

The *Pioneer* differs from the others slightly, being 5 feet longer, 3 inches wider, and of 65 more tons displacement.

The available facts with regard to their trials held during the year are given in the following table:

	Ship.					
	Psyche.	Pomone.	Pyramus.	Prometheus.	Pioneer.	Perseus.
Kind and number of boilers[1]	8 T.	8 B.	8 R.	8 T.	8 T.	8 T.
THIRTY HOURS' COAL-CONSUMPTION TRIAL AT HALF POWER (3,500 I. H. P.).						
Date of trial	Feb. 15	Feb. 16	May 27	June 24	Aug. 31	1898.
State of weather	....	Good.	....	....	....	....
State of sea	....	....	....	....	....	....
Mean results:						
Air pressure ... inch	....	....	....	.39	....	....
Revolutions	170.7	173.2	176.5	177.2	205.8	....
Coal consumption ... pounds	2.3	2.45	2.05	2.01	2.2	2.1
Steam at boilers ... do	....	242	245	253.4	247	....
Steam at engines ... do	....	....	....	....	....	....
Vacuum ... inches	25.9	25	27.2	25.5	25.75	....
Speed ... knots	16.8	16.5	17.49	17.5	16.3	17.2
Speed on six special runs ... do	....	....	....	....	17.58	....
Total I. H. P	3,637	3,609	3,605	3,556.9	3,665	3,600

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[1] All water-tube boilers; T, Thornycroft; R, Reed; B, Blechynden.

EIGHT HOURS' CONTINUOUS STEAMING TRIAL AT NATURAL DRAFT (I. H. P., 5,000).

	Ship.					
	Psyche.	Pomone.	Pyramus.	Pometheus.	Pioneer.	Perseus.
Date	Feb. 18	Feb. 21	May 28	June 27	Sept. 2	1898.
Weather	....	Bad.	....	....	....	....
Sea	....	Rough.	....	....	....	....
Air pressure.......inches	....	1.4	....	.87	....	....
Revolutions	....	201	205	196.9	235.1	....
Coal consumption.......pounds	....	....	2.46	....	....	2.27
Steam at boilers.......do	....	220	247	264.9	262	....
Steam at engines.......do	....	....	....	261.5	245	....
Vacuum.......inches	....	24.4	27.25	25.4	25	....
Speed.......knots	19.5	20.2	19.9	19.8	17.6	19.1
Total I. H. P	5,000+	5,540	5,424	5,183.6	5,263	5,238.8

FOUR HOURS' FULL-POWER FORCED-DRAFT TRIAL (I. H. P., 7,000).

Date	Feb. 21	Feb. 25	May 31	June 19	Sept 4	July 7
Weather	....	Fine.	....	....	....	....
Sea	....	Fair.	....	....	....	....
Air pressure.......inches	3.7	2.83	....	2.58	....	2.39
Revolutions	217.8	220.65	220.3	222.5	264.7	214.7
Coal consumption.......pounds	....	....	....	....	....	....
Steam at boilers.......do	239	252	261	262.6	262	265.9
Steam at engines.......do	....	....	....	....	....	....
Vacuum.......inches	25.39	23.45	26.2	24.05	23.6	23.75
Speed.......knots	20.48	20.8	20.7	20.8	20	20
Total I. H. P	7,006	7,340.1	7,303	7,274.7	7,192	7,068.7

POMONE.

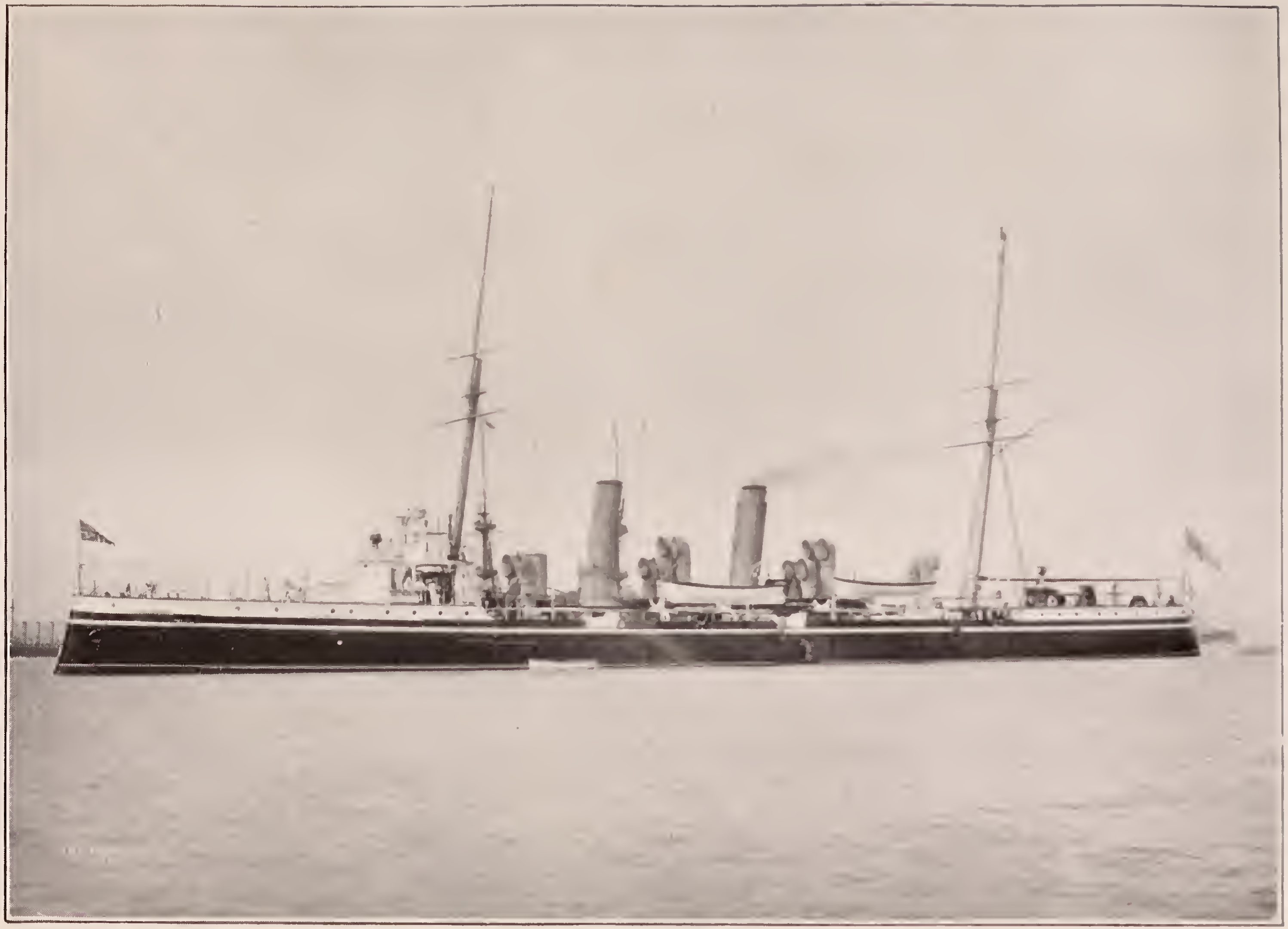
(Page 51, No. XV; page 21, No. XVII, Part I.)

The *Pomone* is in every respect the duplicate of the *Pactolus*, which was also fitted with the Blechynden water-tube boilers, a comparatively new type. The *Pactolus* made the following record: At her thirty hours' trial, with a total I. H. P. of 3,631, a speed of 16.6 knots, with a coal consumption of 2.46 pounds per unit of power; at her eight hours' natural-draft trial, with a collective horsepower of 5,428, a mean speed of 19.1 knots an hour, and at her four hours' forced-draft trial, with 7,201 horsepower, a speed of 20.5 knots an hour, this last speed being attained in spite of very rough weather.

From the results of the *Pomone's* trials, set down in the above table, it will be seen that the contract-power requirements were exceeded at each, and that the engineers have beaten their own power record made in the case of the *Pactolus*, which was the highest then attained in this class of vessel. The trials of the *Pomone* have also been noteworthy, in that they have been continuous and without a break, and, taking the time actually occupied in accomplishing them, have been completed within a week.

BARHAM.

This third-class cruiser of 1,830 tons held a satisfactory eight hours' trial at Portsmouth in May, after a complete refit, including the sub-



PACTOLUS. (British cruiser.) 2,135 tons; I. H. P. (nat.), 5,000; speed, 18.5 knots; launched 1897.

stitution of seven Thornycroft water-tube boilers for her former steam generators. The vessel drew 11 feet 9 inches forward and 14 feet 9 inches aft. The vacuum was 26.5 inches starboard and 27.5 inches port. The pressure in the boilers was 147 pounds, while the revolutions were 191.9 starboard and 191 port. The total I. H. P. was 4,490, and with a mean air pressure of 0.39 inch a speed of 18.6 knots was realized. The three hours' forced-draft trial was also satisfactory. With the same draught of water and with 145 pounds of steam in the boilers, it was found that the former difficulties with regard to vibration and the failure of the reducing valves between the boilers and engines had entirely vanished. The vacuum was 25.2 inches starboard and 25.3 inches port, while the revolutions were 210.6 starboard and 210.7 port. The total I. H. P. was 3,076 starboard and 3,074 port, or a gross total of 6,150. The mean air pressure was 1.9 inches. The vessel was required to realize at least 6,000 I. H. P., but the best hour's run produced a total of 6,400. The mean speed was somewhat over 19 knots.

Later the *Barham* carried out a series of progressive trials, which were ordered for the purpose of comparing results with later third-class cruisers like the *Pelorus* and *Pandora*. The trials were begun on August 10 and 11, when the ship was run at her load draught of 11 feet 9 inches forward and 14 feet 9 inches aft, and they were continued on the 16th and 17th at her light draught of 10 feet 6 inches forward and 14 feet 6 inches aft. In each case the result is a mean of four runs over the measured mile in Stokes Bay:

	Light draught.	Load draught.
Revolutions per minute	100.1	101.2
Steam in boilers ......pounds..	132	130
Indicated horsepower	551	616
Speed in knots	10.138	10.078
Revolutions per minute	143.5	143.9
Steam in boilers ......pounds..	138	127
Indicated horsepower	1,701	1,899
Speed in knots	14.266	14.164
Revolutions per minute	177	183.5
Steam in boilers ......pounds..	138	129
Indicated horsepower	3,242	3,683
Speed in knots	17.553	17.837
Revolutions per minute	201.2	204.4
Steam in boilers ......pounds..	138	138
Indicated horsepower	5,008	5,410
Speed in knots	19.512	19.585
Revolutions per minute	210.4	202.2
Steam in boilers ......pounds..	142	128
Indicated horsepower	5,870	5,280
Speed in knots	20.069	19.491

BELLONA.

The *Bellona*, a sister ship to the *Barham*, which has also been fitted with Thornycroft water-tube boilers, carried out an eight hours' full power natural-draft trial on October 19, but in order to save the daylight she returned into harbor at the end of a seven hours' run. She developed 4,250 horsepower, which gave a speed of 18.8 knots. On the following day she had a four hours' forced-draft trial, developing 6,038 I. H. P., and making a speed of 19.75 knots.

SEAGULL.

The *Seagull*, torpedo gunboat of 735 tons displacement, the only vessel in the English navy provided with the Niclausse type of water-tube boiler, carried out a satisfactory eight hours' steam trial at Portsmouth on June 6. The trial of the boiler was begun some months before this date, but was abandoned in consequence of the excessive vibration, a defect which has since been remedied by balance weights. The engines were required to develop 2,500 I. H. P., and the mean of eight hours was 2,664 I. H. P. The steam in boilers was 150 pounds to the square inch, which was found to be in excess of the amount required to produce 240 revolutions a minute, as stipulated, and which gave the ship the speed of 17.5 knots, with a coal consumption of 1.76 pounds per unit of power per hour.

On a three hours' full-power trial the vessel drew 8 feet 7 inches forward and 10 feet 4 inches aft, and had 250 pounds of steam in boilers with 220 pounds at the engines. The mean vacuum was 25.5 inches, and the revolutions 265 per minute. The mean I. H. P. for the three hours was 3,629, which gave an average speed of 19.15 knots.

In September the *Seagull* commenced five trials, each of a thousand miles, to determine her most economical rate of coal consumption. The trials of the *Seagull* differ from those carried out similarly by the *Sheldrake*, as the latter used three out of her four Babcock & Wilcox boilers, whereas the *Seagull* used four out of her six Niclausse boilers. Four of these runs were to be at 1,350 H. P., two at 1,600, two at 1,780, and one at 1,900.

At the first of these runs the average speed was 13.2 knots.

The third run was completed on October 16, and was run without a break. The vessel drew 9 feet 9 inches forward and 11 feet 3 inches aft, and, with 1,369 horsepower, maintained a speed of 12.99 knots, on a coal consumption of 2.1 pounds per unit of power per hour.

SHELDRAKE.

The *Sheldrake* was commissioned on the 14th of February, 1899, and since that date has gone through a series of nine 1,000-mile runs at various rates of steaming, during which the three after boilers only were used, the fourth—the forward—being held in reserve (cold). The program of the trials to be gone through while in commission were: Four 1,000-mile runs with engines developing 1,500 horsepower, two at 1,800 horsepower, two at 2,000, and one at 2,250 horsepower. The first four trials, which were commenced on February 28, March 14, April 7, and April 14, respectively, were satisfactorily completed, the economy realized averaging 1.58 pounds of coal per I. H. P. per hour, the weight of coal burnt per square foot of fire grate being 12.5 pounds.

The results attained on the 2,000 horsepower runs, which commenced on June 4 and July 3, respectively, were a coal consumption of 1.56 pounds per hour, the coal burnt per square foot of grate being 16.5 pounds.

On May 5 and June 8, respectively, the runs at 1,800 horsepower were commenced, the coal consumption during each of them being 1.6 pounds per I. H. P. per hour, and the quantity burnt per square foot of grate 15.25 pounds.

On July 17 the ship left for the ninth and last of the runs, when the following results were realized: I. H. P. developed, 2,250; coal burnt per I. H. P. per hour, 1.62 pounds, a weight of 18.75 pounds of coal being burnt per square foot of fire grate.

During the second and fourth runs the average speed was 14.7 knots per hour, and during the second 13.8 knots per ton of coal.

DWARF.

(Page 18, No. XVII, Part I.)

The new first-class gunboat *Dwarf* completed her trials in June. On the thirty hours' run the mean speed attained was 11.6 knots; the coal consumption was 2.23 pounds per I. H. P. per hour; the pressure of steam in boilers was 193 pounds; vacuum, starboard 25 inch, port 25.3 inch; revolutions, starboard 227.6, port 227.5; I. H. P., starboard 350, port 352; total, 702; air pressure, 0.27 inch.

In her eight hours' trial under natural draft the mean results were: Steam in boilers, 212 pounds; vacuum, starboard, 25.5 inch, port 25.4 inch; revolutions, starboard, 237.7, port 255.4; I. H. P., starboard 483; port 476; total 959; air pressure 0.4 inch; speed 13.1 knots.

In her four hours' full-power trial, the mean results were: Steam, 221 pounds; vacuum, starboard 25.6 inch; port, 26 inch; revolutions, starboard, 286.5; port, 292; I. H. P., starboard, 694; port, 700; total, 1,394; air pressure, 1 inch; speed, 14.15 knots per hour. The vessel has thus exceeded by more than a knot the maximum speed it was calculated she would attain.

THISTLE.

(Page 18, No. XVII, Part I.)

This vessel, a sister ship to the *Dwarf*, of 710 tons displacement, completed her contract steam trials in August. The satisfactory results which the *Dwarf* attained have been eclipsed by those of the *Thistle*, which proved to be a far more economical steamer. The mean results are as follows:

Thirty-hours' trial.—Steam in boilers, 186 pounds; at engines, 175 pounds; vacuum, starboard, 26 inches; port, 26.5 inches; revolutions, starboard, 230.5, port, 229.5; I. H. P., starboard, 344, port, 352; total, 696; speed, 11.5 knots; coal consumed per I. H. P. per hour, 2.13 pounds.

Eight-hours natural-draft trial.—Steam in boilers, 215 pounds; at engines, 205 pounds; vacuum, starboard, 25.5 inches; port 25.7 inches; revolutions, starboard 254.5, port, 255; I. H. P., starboard, 475, port, 485; total, 960; air pressure, 0.5 inch; speed, 13 knots; coal consumed per I. H. P. per hour, 2.15 pounds.

Four-hours' forced-draft trial.—Steam in boilers, 220 pounds; at engines, 200 pounds; revolutions, starboard, 280 inches, port, 282 inches; I. H. P., starboard, 680, port, 670; total, 1,350; air pressure, 0.75 inch; coal consumed per I. H. P. per hour, 2.47 pounds; speed, 13.5 knots.

TRIALS OF RESERVE VESSELS.

Eight ships that have for some years been in the reserve fleet at Portsmouth have been ordered to carry out their triennial full authorized natural-draft power trials. The *Iris*, which was placed first in the list, had her trial in stormy weather on September 29. She drew 17 feet 9 inches forward, and 21 feet 3 inches aft, and had 52 pounds of steam in boilers, which produced 81.1 revolutions per minute. The mean horsepower was 4,949, and the speed, by patent log, 15.43 knots.

As these ships are from 20 to 30 years old, their present speeds, with the dates of completion, furnish curious points of comparison. The *Iron Duke*, completed in 1871, maintained a speed of 9.25 knots; the *Glatton* (1872), 9.7; the *Sultan* (1871), 13.5; the *Nelson* (1880), 11.3; the *Swiftsure* (1872), 11.5; the *Invincible* (1870), 11.27; the *Hercules* (1868), 13.6; and the *Neptune* (1878), 11.25 knots. Most of the ships had foul bottoms, not having been specially docked for the trials. It will thus be seen that the speed of a squadron of these oldest seagoing warships is 9 knots.

Cruisers.

RUSSIA.

GILIAK.

(Page 79, No. XII, Part I.)

The trial trips of the gunboat *Giliak* were held at Cronstadt on July 13, 1899. Six runs over the measured mile gave an average speed of 11.25 knots, with the sea calm, and the ship drawing 9 feet 1 inch of

Fig 5

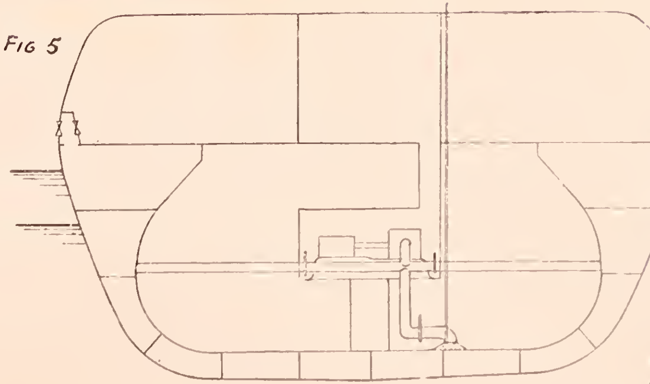


Fig. 3

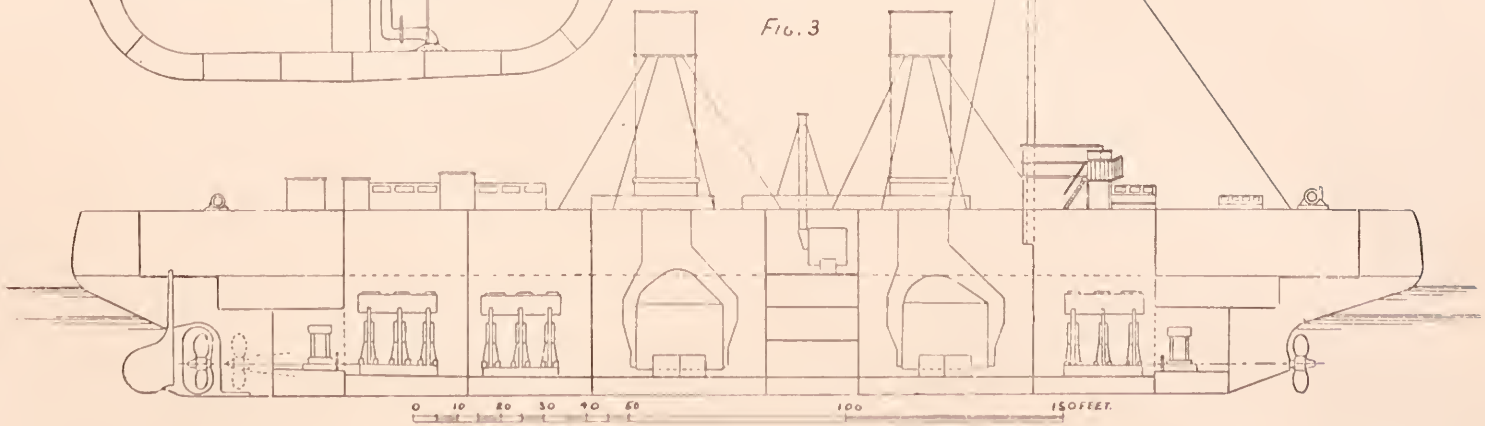
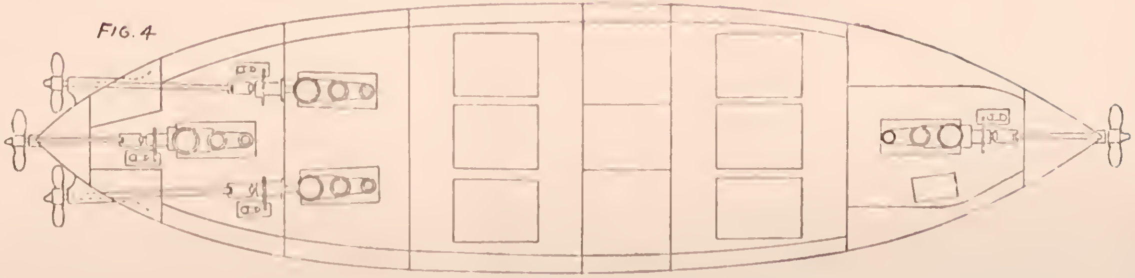


Fig. 4



ERMACK. (Russian ice breaking steamer.)

water forward and 10 feet 7 inches aft. The engines worked satisfactorily, but the steam pressure varied considerably; the starboard engine, with pressures of from 105 to 155 pounds, made 192 to 210 revolutions, and the port engine, with 122 to 135 pounds, made 190 to 210 revolutions per minute. The engines developed 933.79 I. H. P., while 1,000 is required under the contract. This deficiency is attributed to the poor quality of Russian coal.

ERMACK.

Ice-breaking steamer. The trials of the *Ermack* commenced with a four hours' consumption run, with the main propelling engines developing a combined horsepower of 8,000, when the consumption of coal was found to be 1.52 pounds per I. H. P. per hour. The machinery was then driven at full power, with the three after propellers working ahead, and the forward propeller astern, or in opposition to the after ones. Under this condition the engines developed 11,250 horsepower, a speed of close on 16 knots being attained, or practically the same rate as when all four screws were running ahead. On the completion of the above trials the main propelling engines were disconnected, the auxiliary screw engines connected to the shafts, and the ship driven at a slow speed, the results throughout being highly satisfactory.

During the protracted two days' trials of the ship thick weather prevented the section post on the measured mile from being seen, and speed was, therefore, taken by log. The practical result which has been arrived at seems to be that the speed with 8,000 horsepower was nearly 15.25 knots. The speed with the three after engines working ahead was about 15.5 knots, and the speed with all the engines running ahead was about 16.25 knots, the power in each case being at the maximum. The highest indicated power developed was 12,000, and this corresponds with the speed of 16.25 knots. With the three after engines working ahead and the forward engine working astern the power was 11,250, of which the forward engine was never developing more than 2,000.

FRANCE.

TAGE.

The first-class cruiser *Tage*, of 7,345 tons displacement, carried out her annual trials from the Reserve at Brest in the early summer. For two hours, with the engines making 85 revolutions, the speed maintained was 18 knots.

GUICHEN.

(Page 19, No. XIV; 29, No. XV.)

The French first-class station cruiser *Guichen* has as yet attained a speed of only 22 knots in her trials, whereas 23 knots was the speed expected of her. The ship is now being provided with new screws, after which it is hoped she will be able to attain the desired speed. It was shown, however, that the *Guichen* can easily maintain an average speed of 20 knots for an indefinite time, which, at all events, indicates good results.

The *Guichen* on June 27, with 18,500 horsepower (it ought at full power to develop 23,000), the screws making 112 turns, made a speed of 20 knots. In the preliminary trials the vessel has not been able to make the 23 knots expected of her, but has made 22 knots. It is hoped that with new screws she will attain the desired results.

It has now been decided to reduce the diameter of the propellers, increase the revolutions, and also to alter the disposition of the weights on board. The general results of the trials of this ship have been so disappointing that, as far as possible, all the details are being kept dark.[1]

LAVOISIER.

(Page 169, No. XVI, Part IV.)

The third-class cruiser *Lavoisier*, belonging to the Mediterranean Squadron, carried out some full-speed trials on the measured mile off the Hyères Islands, when she attained a speed of 21.4 knots.

DUNOIS.

(Page 11, No. XVII, Part I.)

The full-power trials of the 896-ton torpedo gunboat *Dunois* off Cherbourg, May 31, were not so successful as was at first anticipated, as the highest speed she realized was only 21.7 knots instead of the 23 provided for in the contract. At this trial the engines and boilers worked without a hitch, and she developed 7,719 I. H. P., with a coal consumption of 1.856 pounds per unit of power. The number of revolutions was 270.

LA HIRE.

The *La Hire*, a sister to the *Dunois*, held her trials off Cherbourg in September. During a twenty-four hours' run at 2,600 I. H. P. a mean speed of 23 knots was maintained; her four hours' full-speed trial was unsuccessful, owing to hot bearings.

GERMANY.

HANSA.

(Page 30, No. XIV; page 42, No. XV.)

The *Hansa*, protected cruiser of 6,100 tons displacement, in a full-speed run at Stettin on May 26 attained the speed of 21.5 knots, the contract speed being 19 knots.

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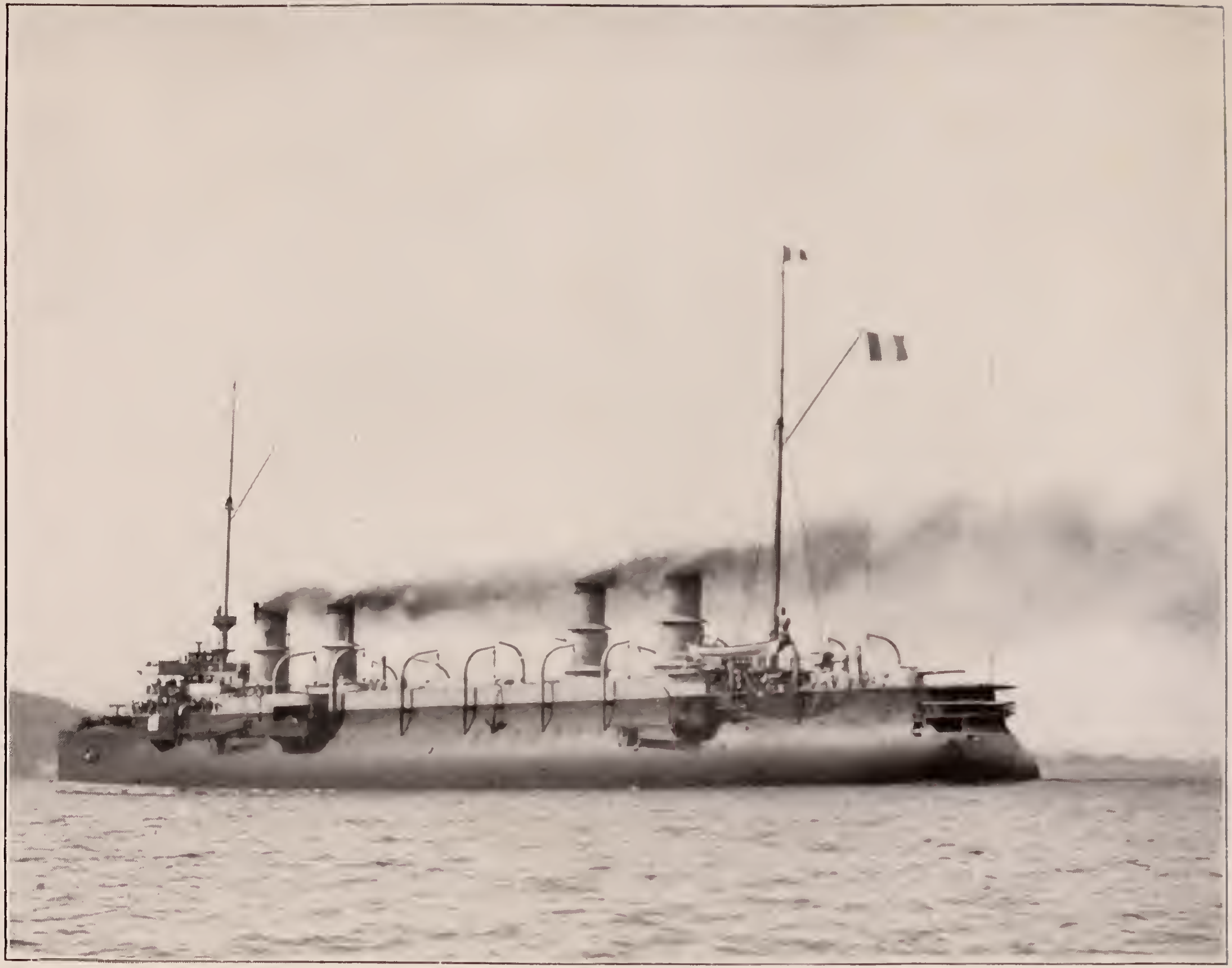
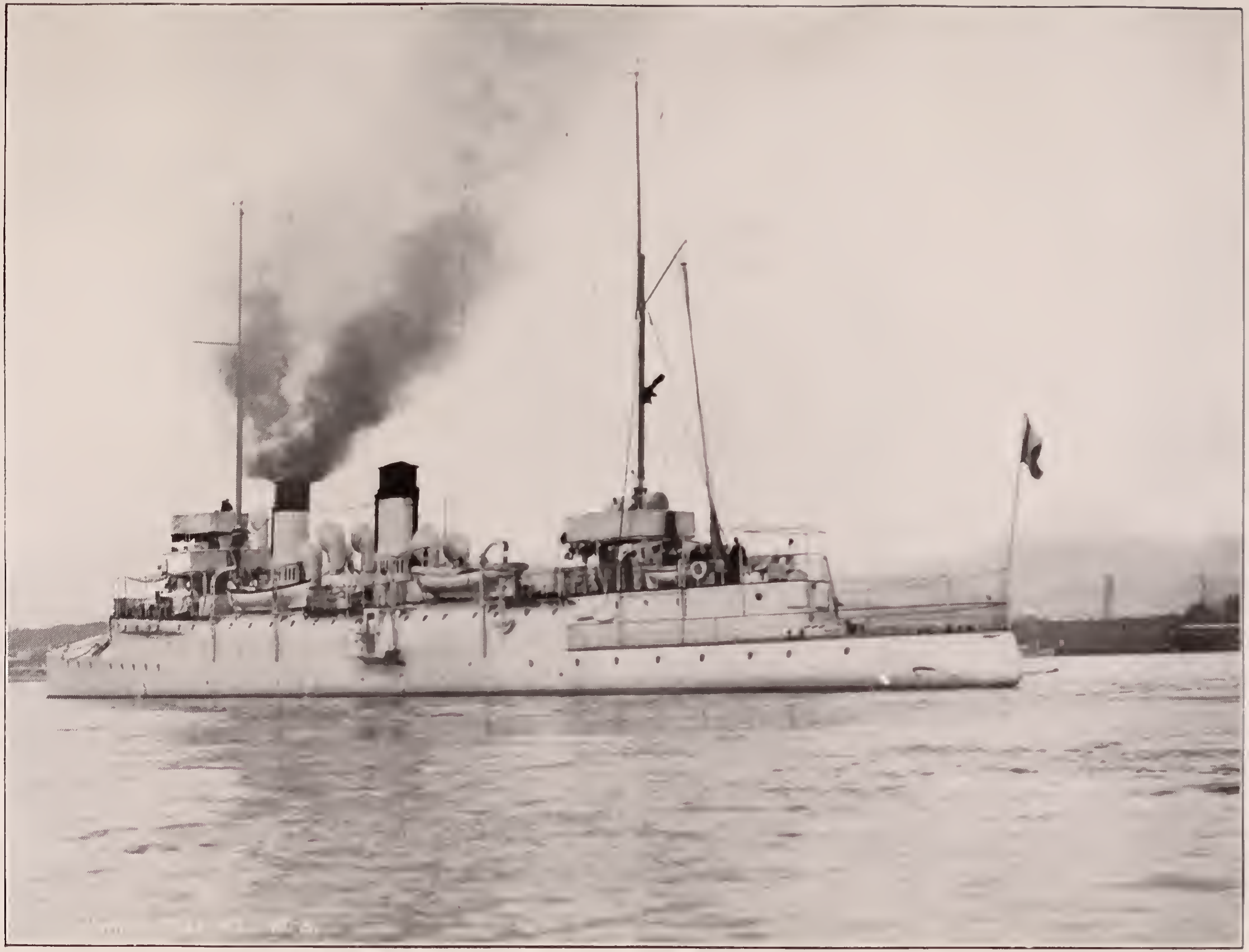
[1] On November 12 the *Guichen* made a successful trial, developing 25,350 H. P. and making for more than three hours an average speed of 23.5 knots.



GUICHEN. (French cruiser.) 8,277 tons; I. H. P., 14,500; speed, 20 knots, launched 1897.



DUNOIS. (French gunboat.) 896 tons; I. H. P., 7,000 speed 23 knots launched 1897

VICTORIA LUISE.

(Page 30, No. XIV; page 42, No. XV.)

During the thirty hours' trials the engines and Dürr water-tube boilers of this protected 6,100-ton cruiser worked very satisfactorily, and on the forced-draft trial the average speed was 19.1 knots. The guaranteed speed with forced draft for 10,000 I. H. P. was 18.5 knots.

ITALY.

VETTOR PISANI.

(Page 158, No. XII; page 66, No. XV.)

The first-class armored cruiser *Vettor Pisani* underwent her trials successfully. At her eight hours' natural-draft trial the engines developed 8,290 I. H. P., giving a speed of 17.5 knots, at a coal expenditure of 889 grammes per H. P. per hour.

JAPAN.

ASAMA.

The *Asama*, the latest cruiser built in a British yard for the Imperial Japanese navy, underwent a most satisfactory trial. The horsepower developed was rather over 13,000, giving 140 to 142 revolutions per minute, and a speed by log averaging 20.37 knots. During the forced draft trials, with a moderate sea but a strong beam wind off the land, the engines, built by Messrs. Humphrys & Tennant, worked up to 19,000 horsepower, with 158 revolutions and a mean speed for the vessel of 22.07 knots. There are many points of considerable interest in the *Asama*. Both engines are supplied with steam from cylindrical boilers, the boilers being placed back to back and stoked from the wings, and they give 13,000 horsepower without forced draft, and 18,000 with 2 inches of air pressure. The guaranteed speeds are 20 knots at the lower and 21¼ at the higher power, but these speeds were exceeded in practice. The boilers are worked at 150 pounds pressure, and the engines have a comparative short stroke, so as to keep the whole of the cylinders below the armored deck, which is 2 inches thick and extends to the ends of the ship. The propeller works outward and vibration is small at all speeds. The high and intermediate cranks are set at an angle of 170 degrees, the two low-pressure cylinder pistons having cranks at the same angle, one from the other, but the mean line of the latter is at right angles to the mean line of the high and intermediate cranks. The vessel's coal stowage is 700 tons normal, and 1,450 tons can be carried, all in bunkers, and this larger quantity may be considerably increased by temporary means without impairing the seagoing qualities of the vessel.

On her way to Chatham the *Asama* made 20 knots, natural draft, without difficulty, with a foul bottom, and with Japanese stokers fresh to the ship. The ship was at the time rather lighter than her normal displacement, still the result may be looked upon as a brilliant one.

TOKIWA.

At her speed trials runs were made at 10, 15.6, 18.8, 21.2, and 22.73 knots, and during six hours the vessel ran at a mean speed of 20.85 knots with open stokeholes. At her last trial she ran for three hours, with a pressure in her stokeholes scarcely exceeding 1½ inches, at a mean speed of 23.1 knots. She has 12 single-ended cylindrical boilers.

CHITOSE.

On her official trial she made a six-hour run over the course in Santa Barbara Channel, averaging 21.048 knots per hour, whereas but 20.5 knots are required, and developing a maximum speed of 21.38 knots under natural draft. The vessel has been accepted with the reservation of the forced-draft test, which has not yet been reported. This cruiser has averaged 22.867 knots upon two separate occasions, but as the contract calls for the maintenance of 22.5 knots during two consecutive hours, a formal test will be made under the forced draft.

Evolution tests made under full speed were very successful, the *Chitose* turning in a radius of 300 feet and being stopped from full headway to going astern within her own length.

At her official trial outside San Francisco Harbor the *Chitose*, in a run of two hours forty-five minutes, averaged 22.87 knots, the highest speed attained being 23.76 knots.

AUSTRIA.

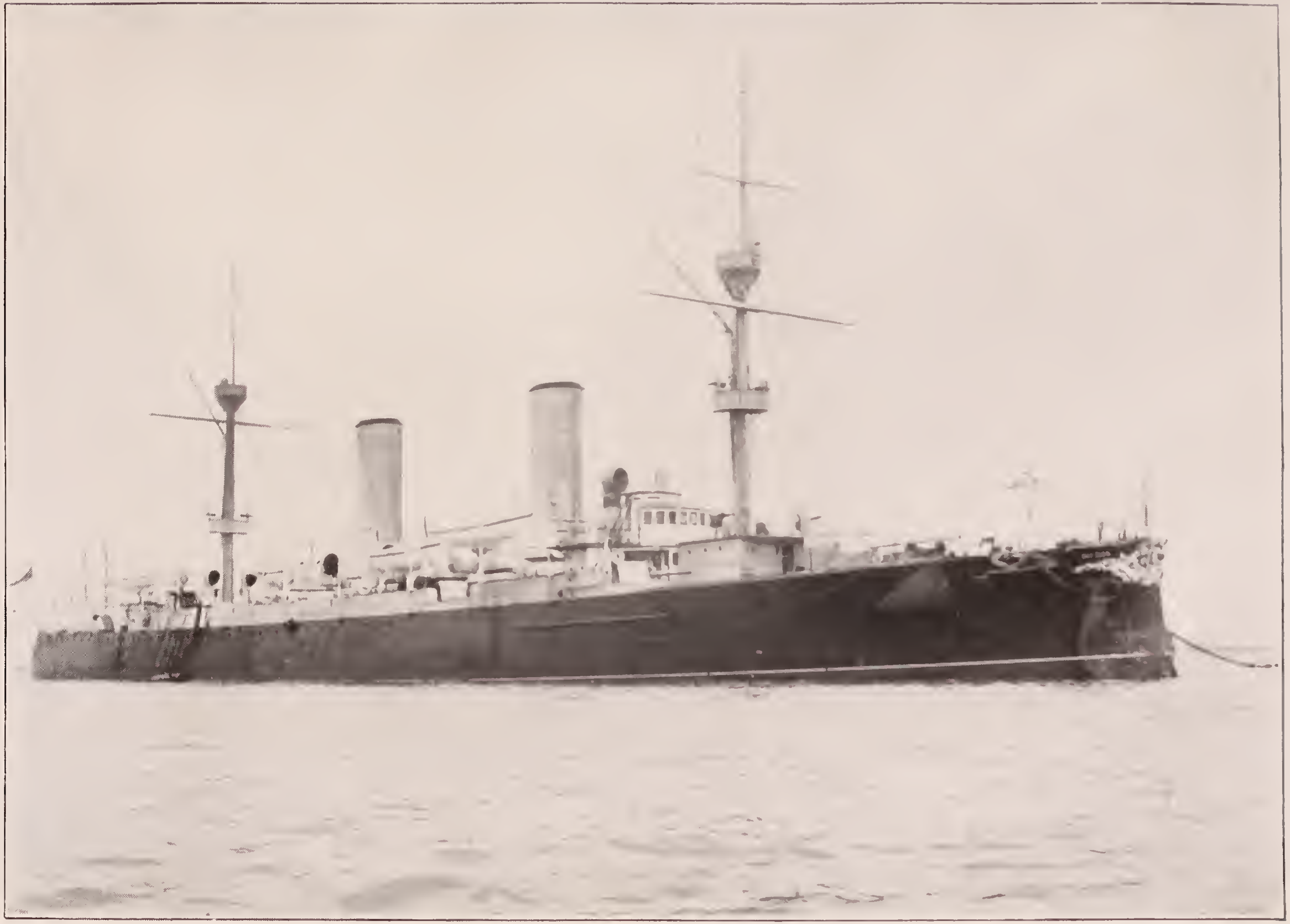
ZENTA.

The Imperial and Royal Austro-Hungarian cruiser *Zenta*, constructed by the Stabilimento Tecnico Triestino, successfully passed all her official trials in the Adriatic in April, attaining with ease the speed of 20.9 knots mean with 7,800 indicated horsepower, which is 8 per cent above the guaranteed power. This fine vessel is 312 feet long by 40 feet beam, and about 2,300 tons displacement. The triple-expansion twin-screw engines are supplied with steam by eight Yarrow water-tube boilers.

PORTUGAL.

DON CARLOS I (PROTECTED CRUISER).

The steam trials took place off the mouth of the Tyne, the speed being taken over the admiralty measured mile. The first trial was for six hours with open stokeholes, run under the British admiralty



HAITIEN. (Chinese cruiser.) 4,300 tons; I. H. P., 17,000; speed, 24 knots; launched 1897.

conditions on March 9, and the mean speed obtained during six runs over the course was 20.66 knots, the I. H. P. developed being 8,000. The forced-draft trial on March 30 resulted in the vessel obtaining, as a mean of four runs over the measured mile, a speed of 22.15 knots, the I. H. P. developed being 12,500. During the trials the engines worked smoothly throughout. For six hours, with one-half inch of air pressure, about 8,000 horsepower was developed and a mean speed of 20.64 knots obtained; and during her forced-draft trial, with a pressure not exceeding 2 inches, 12,690 horsepower was realized, and a mean speed of 22.15 knots was obtained in a considerable sea and half a gale of wind. It was recognized that with a smooth sea and no wind the vessel could easily have steamed 22½ knots.

SÃO RAFÄEL, SÃO GABRIEL (THIRD-CLASS CRUISERS).

On the official trial, which took place on the measured mile off La Hève, the mean speed under natural draft for four hours was 15.7 knots, while under forced draft, with an air pressure of 15 to 20 millimeters (0.59 to 0.79 inch), the mean speed maintained was 17.53 knots, which was an excess of 0.5 of a knot over the contract.

CHILE.

GENERAL BAQUEDANO (TRAINING SHIP).

During her recent steaming trials she attained a speed of 13.75 knots. I. H. P., 1,500.

CHINA.

HAI TIEN (PROTECTED CRUISER).

This vessel completed her steam trials on March 28 with very satisfactory results. She steamed for six hours with a pressure in the stokeholes not exceeding that corresponding to a head of one-half inch of water, and for four hours with a pressure in the stokeholes not exceeding that corresponding to a head of 2 inches of water. The mean of four runs over the measured mile during the six hours' run was 22.64 knots, and the mean of four runs during the forced-draft trial was 24.1 knots.

With open stokeholes the I. H. P. developed was 12,000; during the forced-draft trials, 17,000.

TORPEDO BOATS.

Data concerning destroyers and torpedo boats tried in 1899.

Name.	Builders.	Year of launch.	Displacement.	Contract—		Kind of boilers.
				I. H. P.	Speed.	
ENGLAND.			*Tons.*		*Knots.*	
Albatross	Thornycroft	1898	360	7,500	32	Thornycroft.
Bullfinch	Earle	1898	300	5,800	30	
Cheerful	Hawthorn, Leslie	1897	308	6,000	30	Do.
Coquette	Thornycroft	1898	285	5,800	30	Do.
Cygnet	do	1898	285	5,800	30	Do.
Cynthia	do	1898	285	5,800	30	Do.
Express	Laird Brothers	1897	300	7,500	33	
Flirt	Palmer	1897	324	6,000	30	
Kestrel	Clydebank Co	1898	300	6,000	30	
Leven	Fairfield Co	1898	300	6,000	30	
Lynx	Laird Brothers	1894	280	4,000	27	
Mermaid	Hawthorn, Leslie	1898	308	6,000	30	Do.
Orwell	Laird Brothers	1898	300	6,000	30	
Otter	Naval Construction Co	1896	300	6,000	30	
Spiteful	Palmer	1899	322	6,000	30	
Wolf	Laird Brothers	1897	300	6,000	30	
FRANCE.						
Durandal	Normand	1898	300	4,800	26	Normand.
Hallebarde	do	1899	300	4,800	26	Do.
Lansquenet	Oriolle, Nantes	1893	150	2,800	26	Oriolle.
No. 218	Schneider & Co	....	86	1,500	24	Temple-Guyot.
ITALY.						
Condore	Ansaldo, Sestri	1898	136	2,500	27	
Fulmine	Odero, Sestri	1898	260	4,800	28	
AUSTRIA.						
Python	Yarrow & Co	1898	133	2,000	24	
CHINA.						
Hai Lung	Schichau	1898	280	6,000	32	Schichau.
Hai Nju	do	1898	280	6,000	32	Do.
Hai Ching	do	1898	280	6,000	32	Do.
Hai Hoha	do	1898	280	6,000	32	Do.
JAPAN.						
Murakumo	Thornycroft	1898	279	5,475	30	Thornycroft.
Shinonome	do	1899	279	5,475	30	Do.
Yugiri	do	1899	279	5,475	30	Do.
Shiranui	do	1899	279	5,475	30	Do.
Kagero	do	1899	279	5,475	30	Do.
Ikadsuchi	Yarrow	1898	311	6,000	31	Yarrow.
Inadsuma	do	1899	311	6,000	31	Do.
Akebono	do	1899	311	6,000	31	Do.
Sazanami	do	1899	311	6,000	31	Do.
Oboro	do	1899	311	6,000	31	Do.

GIPSY. (British torpedo boat.) 300 tons; I. H. P., 7,700; speed, 32 knots; launched 1897.

ENGLAND.

ALBATROSS.

The 34.286 knots attained by H. M. S. *Albatross* during her trials over the Maplin course on April 7, 1899, gives her the distinction of being the fastest ship in the English navy. She is considerably larger than the 27 and 30 knot boats already in the service, and the value of the high speed obtained was well shown when running abreast of the destroyer flotilla at their full speed. Undoubtedly the larger vessel is the better sea boat, and has a larger radius of action at high speed, as well as greater comfort for the crew. It is but fair to say that the 34.286 knots was made when running with wind and tide, the weather being very boisterous and squally, the wind velocity varying from about 20 to 30 knots; two runs were, however, made against these conditions, the mean of the three runs showing 32.294 knots. The vessel is well flared at the bow, and was consequently very dry on deck, even when going at full speed against wind and sea, and scarcely showed any heeling, even when turning sharply. The mean pressure at the boilers was 245 pounds and at the engines 240 pounds; the pressure of air, 3.5 inches.

BULLFINCH.

This boat attempted a trial of three hours duration at full power on April 18, but after she had run for half the stipulated period at a speed of only 29.1 knots the trial was abandoned. On July 21 she again carried out six runs on the measured mile in Stokes Bay, the required mean speed being 30 knots; but on her return trip a serious disaster occurred to her machinery,. necessitating the subsequent removal of her engines.

CHEERFUL.

The *Cheerful* made two full-power trials of three hours duration on September 3 and 28. At the first, the coal-consumption trial, the engines indicated 5,632 horsepower, with a speed of 29.941 knots. The coal consumption was 2.84 pounds per I. H. P. per hour. The results of the later trial are: Steam in boilers, 218 pounds; revolutions, 383.9 per minute; vacuum in condensers, 23.6 inches; mean I. H. P., 5,912; mean speed, 30.152 knots.

COQUETTE.

The new destroyer *Coquette* completed her trials in August, with the following results: Draught of water, forward 5 feet 11.5 inches, aft 7 feet 4.5 inches; speed, 30.211 knots; steam pressure in boilers, 216 pounds; air pressure in stokeholes, 2.72 inches; vacuum in condensers, starboard 25, port 24.9 inches;` revolutions per minute, starboard 383.8, port 388.6; mean I. H. P., starboard 2,820, port 3,048; total, 5,868. The contract requirements were thus exceeded.

CYGNET.

The results of the official trials of the *Cygnet*, on May 15, were very satisfactory. Although a strong wind was blowing throughout the trial, a mean speed was obtained of 30.356 knots on the measured mile, the revolutions of the engines being 395.5 per minute, and during the three hours' trial a mean speed of 30.304 knots was maintained, the revolutions of the engines in this latter case being 393.7 per minute. The boilers gave ample steam, and the machinery no trouble from hot bearings. After the completion of the three hours' run the steering trials were carried out satisfactorily.

CYNTHIA.

This destroyer of 30 knots speed made a satisfactory three hours' trial at Chatham, in September, with the *Cheerful*.

The *Cynthia* underwent a full-power official trial of her machinery in the North Sea, October 26, which proved successful. Designed to steam 30 knots with the forced draft, the vessel averaged 30.30 knots on a three hours' run. The engines registered 5,500 I. H. P., or 100 in excess of the estimate.

EXPRESS.

The torpedo boat destroyer *Express* had a trial on the Clyde on May 18, reaching a speed of 32 knots. It is expected that after one or two adjustments of details have been made in the engine room the speed of 33 knots will be realized.

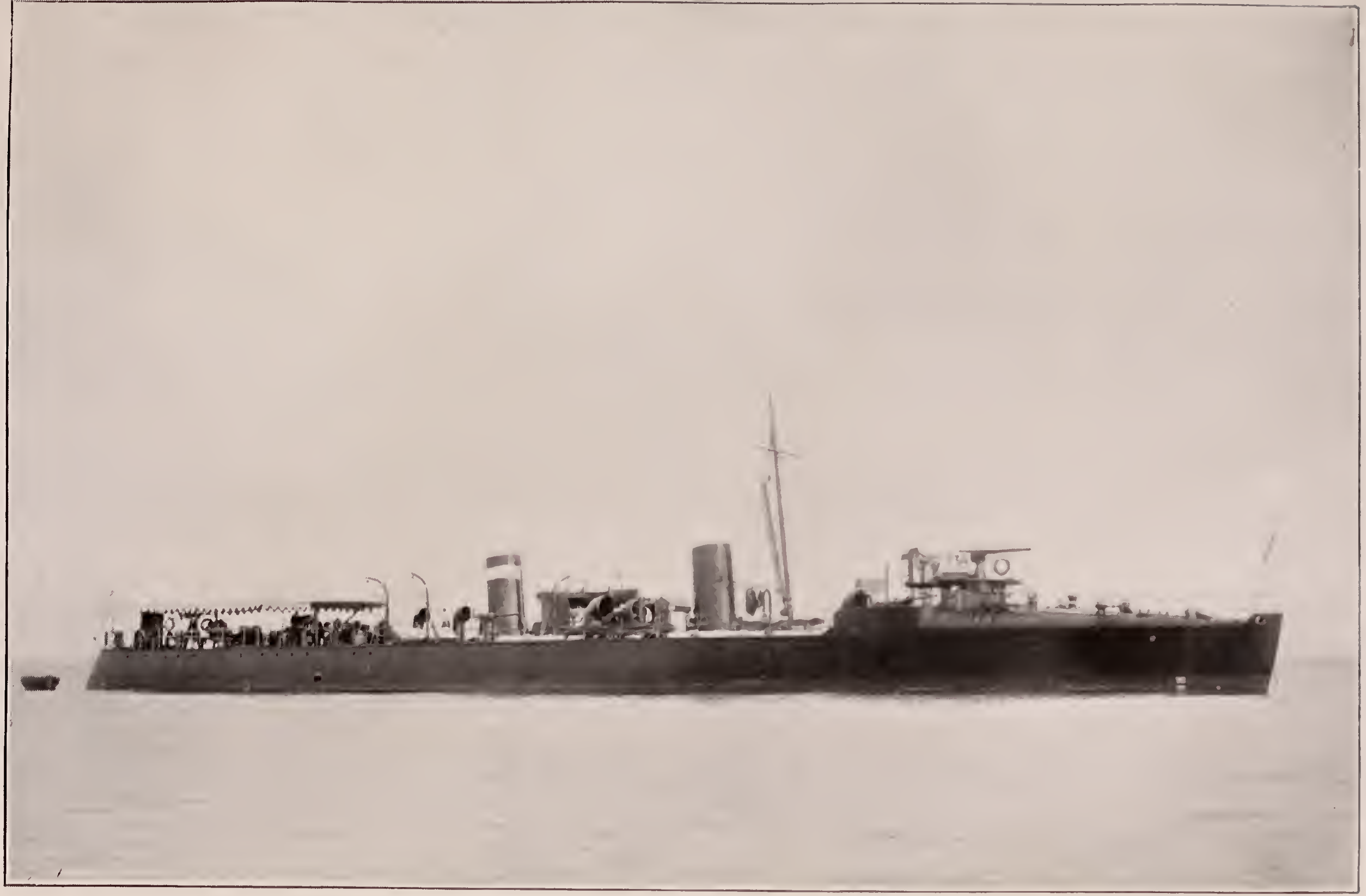
FLIRT.

The destroyer *Flirt* ran a coal-consumption trial of eight hours duration on January 6 at Portsmouth at economical speed. With 475 horsepower and 154 revolutions she made the speed of 13 knots with a coal consumption of 1.87 pounds per I. H. P. per hour.

KESTREL.

On March 15 the *Kestrel* went for the official coal-consumption trial at full speed for three hours, and on the 17th the official full-speed trial took place. Six runs were made on the measured mile at Skelmorlie with a mean of means of 30.406 knots. The vessel subsequently completed the three hours' trial, and after the speed trial stopping, starting, and steering trials were made.

The *Kestrel* returned to Portsmouth on the night of October 17 at the conclusion of a ten hours' economical coal-consumption trial. With 530 horsepower the engines worked up to 165 revolutions, which gave a speed of 13.5 knots, the coal consumption working out at 2.3 pounds per unit of power per hour.



ARIEL. (Torpedo boat.) 278 tons; I. H. P., 5 800; speed, 30.59 knots; launched 1897.

LEVEN.

The destroyer *Leven* completed her official trials on the Cylde during the week ending April 1, and on six runs over the measured mile at Skelmorlie the mean speed obtained was 30.672 knots. The vessel was afterwards run out to Ailsa Craig, and on three hours continuous steaming a mean speed of 30.201 knots was obtained.

On the steering trial, which was subsequently held, some defects developed in her steering gear.

LYNX.

The destroyer *Lynx*, whose mishap with the *Thrasher* off the Cornish coast brought her into such unenviable notoriety, had extensive repairs made, and on June 3 underwent a satisfactory three hours' steam trial off Plymouth, when a speed of 23.8 knots was obtained, the engines indicating 3,594 horsepower. The vessel was not pressed at any part of the trial, and as her engines are capable of developing 4,500 horsepower, her speed can probably be carried to 27 knots, the maximum for which she was designed.

The mean pressure at the boilers was 143 pounds; vacuum, starboard, 23.23 inches; port, 24.75 inches; revolutions, starboard, 326; port, 318; I. H. P., starboard, 1,842; port, 1,752; total, 3,594; air pressure, 4 inches.

MERMAID.

The three hours' full-power coal-consumption trials of the *Mermaid* in April proved very satisfactory. The speed obtained was 30.134 knots. On May 5 she completed her full-power speed trial on the measured mile off the Maplin Sands with very satisfactory results, and proved herself the fastest vessel of the 30-knot destroyer class yet tried. She had a displacement of 320 tons when carrying the specified load at the commencement of the trial. The machinery consists of twin-screw, three-crank, triple-expansion engines, having cylinders 19, 29, and 46 inches by 18 inches stroke. The cranks are set at 120 degrees, and balance weights are fitted upon the high-pressure and low-pressure cranks to counteract the vibratory forces. Throughout the trials the vibration was very slight, and the whole of the machinery ran without the slightest hitch. Steam is supplied by four water-tube boilers of the Thornycroft type, having a total heating surface of about 13,200 square feet and worked at a maximum pressure of 250 pounds per square inch. The mean results of the six consecutive runs on the mile gave 30.927 knots speed with 400.875 revolutions. The maximum speed was 31.304 knots. The general results of the three hours' trial were: Speed, six runs, 30.926 knots per hour; for three hours, 30.833 knots; total I. H. P., 6,541. It will thus be seen that the high speed of 30.833 knots was obtained with a very moderate power.

The *Mermaid* has on all her trials been extremely successful. On her first trip to sea for the contractors' preliminary trial she attained a mean speed of 30 knots—a performance which, it is believed, has not previously been accomplished by any vessel. On the admiralty observation trial, before leaving the Tyne, a speed of nearly 31 knots was obtained, and upon her official consumption trial a speed of 30.149 knots was maintained for three consecutive hours in unfavorable weather. It will thus be seen that this vessel has not once gone to sea on trial without obtaining the contract speed and maintaining it for the necessary specified time.

ORWELL.

The *Orwell*, torpedo-boat destroyer, completed her official trial on May 2, on the Clyde, in the presence of the admiralty officials, with satisfactory results. The mean speed on six runs over the measured mile was 30.7 knots, while the speed for the three hours' continuous steaming was 30.2 knots. The steering trials were also carried out with satisfactory results. The total I. H. P. was 6,080.

OTTER.

The *Otter*, having made good the machinery defects developed on the Clyde while undergoing a six hours' steam trial, repeated the trial on July 12 with highly satisfactory results. With the engines working at 387 revolutions the vessel maintained a mean speed of 30.2 knots.

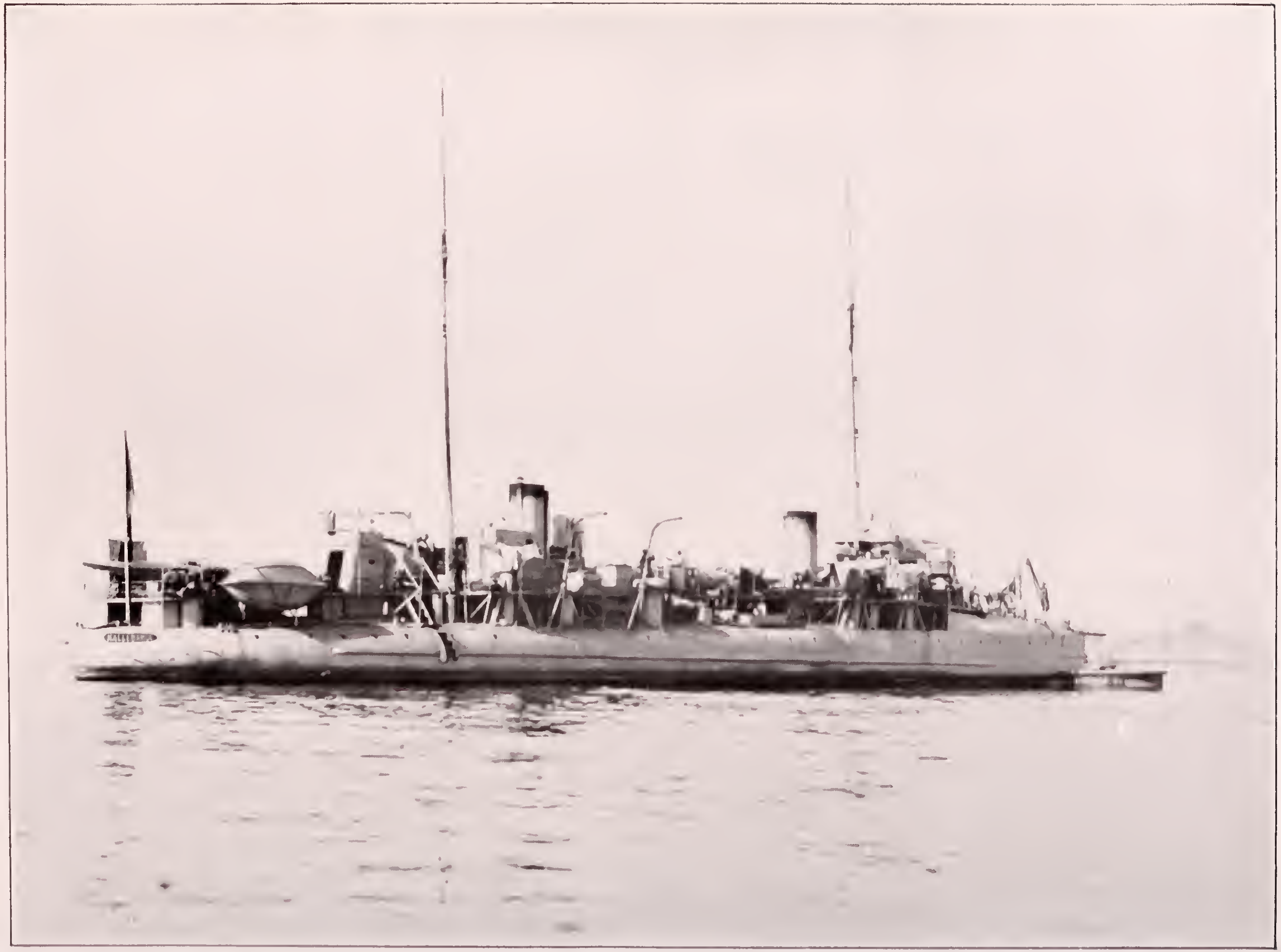
SPITEFUL.

The *Spiteful* had a three hours' coal consumption trial at Portsmouth on September 29. With 6,568 I. H. P. the engines made 406 revolutions starboard and 397.3 port, producing a speed over the measured mile of 29.9 knots, and the coal consumption was 2.33 pounds, which is within the 2.5-pound limit specified.

WOLF.

While cruising with the destroyers *Bat*, *Shark*, and *Thrasher*, in June, the *Wolf* was subjected to a two hours' steam trial, the mean results of which are as follows: Steam in boilers 207 pounds, at engines 197 pounds; vacuum, starboard 17.7 inches, port 23.7 inches; revolutions, starboard 324, port 331; I. H. P., starboard 2,735, port 2,936, total 5,671; air pressure, 2.5 inches; speed, 27 knots. Although the engines worked smoothly throughout, there being no difficulty in maintaining the engines at the power stated, the results, so far as speed is concerned, can not be regarded as satisfactory. The *Wolf* is quite a new vessel, having only recently been delivered by the contractor, yet on her contract trials, with the engines working at 6,000 I. H. P., she recorded a speed of 31.2 knots, that being the highest yet attained by a destroyer.

CYCLONE. (French torpedo boat, seagoing.) 1 [illegible] ns, I. H. P., 4,200, speed, 30 knots; launched 1898.



HALLEBARDE. (French torpedo-boat destroyer.) 300.7 tons, I. H. P., 4,800, speed, 26 knots; launched June, 1899.

FRANCE.

DURANDAL.

The *Durandal* successfully carried out her trials at Cherbourg in May, having maintained during a six hours' run a mean speed of 27.4 knots with 301 revolutions, or more than a knot beyond the speed required by the contract (26 knots). The working of the boilers and engines was perfect.

HALLEBARDE.

The sister boat *Hallebarde* held her trials at the same port in August, During a run of twenty-four hours it gave a mean speed of somewhat more than 21 knots; in a five hours' run, under natural draft, a mean speed of 22 knots was maintained; and in an hours' run, under forced draft, it attained a speed of 27.2 knots, which is more than a knot in excess of the stipulated contract speed.

LANSQUENET.

The seagoing torpedo boat *Lansquenet*, after its first trials, had some alterations made at Brest, and in May carried out some new official trials which gave excellent results.

NO. 218.

At Toulon on August 2 the new torpedo boat *No. 218* successfully concluded her trials, having attained a speed of 25 knots, which was a knot in excess of the contract.

AUSTRIA.

PYTHON.

On March 21 the torpedo boat *Python*, the last of four torpedo boats just built by Messrs. Yarrow & Co., Limited, of Poplar, for the Imperial and Royal Austro-Hungarian Government, attained the speed of 24.34 knots at her official trials, the revolutions being 350 and the steam pressure 170 pounds. The horsepower obtained was 2,000 during the three hours' trial and the load carried was 44 tons, representing the vessel fully equipped under service conditions. The *Python* displaces 115 tons.

ITALY.

CONDORE.

The first-class torpedo boat *Condore*, of 136 tons, began her trials in February with satisfactory runs at 19 and 21 knots, under natural and forced draft, respectively.

She followed these in the summer with a three-hour trial trip with 2,400 horsepower and 350 revolutions, attaining a mean speed of 26 knots and a maximum speed of 26.5 knots.

FULMINE.

The torpedo destroyer *Fulmine*, of 300 tons, 4,800 horsepower, and 28 knots, built by Odero in Sestri-Ponente, made at Genoa in August her preliminary trials, which resulted very satisfactorily.

5. VESSELS RECONSTRUCTED.

TRANSFORMATION OF FRENCH SECOND-CLASS BATTLESHIPS.

The designation "second-class battleships" may to-day be applied to all those which are older than the *Brennus*. This term is more appropriate than that of "old battleships," inasmuch as the newest of them are not yet ten years old. It therefore includes the four battleships *Hoche*, *Marceau*, *Neptune*, *Magenta;* the *Amiral-Duperré*, *Formidable*, *Amiral-Baudin;* the *Redoutable*, *Courbet*, *Dévastation*, and finally our coast-defense vessels *Terrible*, *Requin*, *Caïman*, and *Indomptable*, to which the *Furieux* may, perhaps, be added. In all there are fifteen battleships which by the force of circumstances are to undergo more or less important modifications, occasioned by the progress made and the experience gained in naval matters since their entrance into service.

These modifications come under three principal heads—hull, armament, and boilers and engines.

As for the hull, these battleships were constructed or designed at a time when the chief aim was to protect the water line against large explosive shells. Neither the artillery of rapid-fire guns nor the powerful explosives had as yet made their appearance.

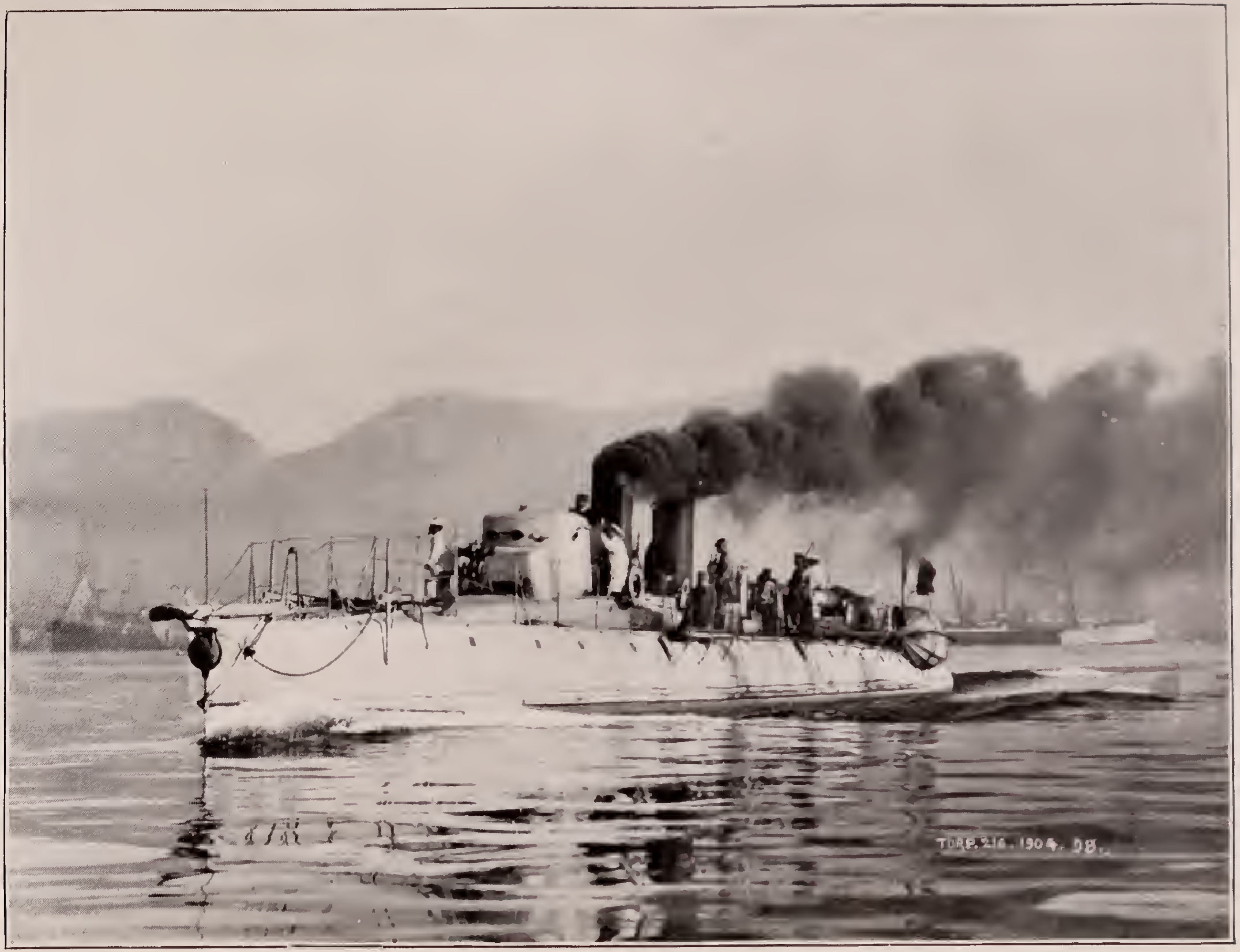
Hence these heavy armor belts, together with all the weight on board, often excessive in consequence of our fondness for making the slightest things too solid at times, have overburdened the greater part of our battleships. The armor consequently extended but little above the surface of the water, whence the expression "submarine armor," employed, with some exaggeration no doubt, by certain critics.

It is none the less true that it was necessary to decrease the weight of all these hulls, especially since the original stability of these vessels being rather slight, an invasion of water above the armored deck could in certain cases seriously endanger their trim.

It is true that for some time past barriers have been constructed above the armored deck to offset this disadvantage, but they constitute only a secondary remedy and cause additional weight.

In order to obtain the decrease in weight desired and recognized as advantageous it was necessary to incur considerable expense. This was done without hesitation, and it was well, in view of the results obtained.

Several ways of decreasing the weight of these vessels have suggested themselves. First, it was decided to do away with a portion of



FRENCH TORPEDO BOAT NO 216.

their superstructures, which constitute a useless weight, favor the bursting of ordinary shells and of those containing powerful explosives, and offer an excellent target for the shots of the enemy. One of the two military masts has been abolished. Another means was used in conjunction with the foregoing, namely, a change in the armament.

In consequence of the progress made in artillery during the past few years it has been possible to conceive the idea of decreasing the number of guns of medium caliber and slow fire by replacing them by similar rapid-fire guns of the same order, but of smaller caliber, of a more recent type and having, nevertheless, equal, if not superior, ballistic power. In this way the two desiderata are realized simultaneously—the improvement of the hull and the improvement of the armament. At the same time the substitution of water-tube boilers for the cylindrical boilers was taken under consideration. Different types have been adopted according to the requirements of the vessels, both for the sake of keeping up emulation among the different contractors and with a view to the interior arrangement peculiar to each ship.

Finally, another modification of the hulls was necessary, since the naval battles of the Yalu and Santiago have shown the disadvantages of wood on board. It is necessary that all the wooden decks be removed from our battleships, and this need has already been taken into account in those ships now in course of transformation.

It will be readily understood that it was not possible to undertake at one time all the work necessary upon the fifteen vessels named above. A first program adopted, distributing the changes to be made over several years, has already had to be modified in several instances, especially in consequence of foreign political events. One can not, in fact, render unavailable (immobiliser) many ships at a time nor for too long a time, in consequence of which certain combinations result which have led to making changes in the armament at one time, in the boilers at another, and in the hull at a third.

However that may be, some results have already been obtained and we are entering upon the most active period of these transformations, which will be briefly enumerated.

The *Redoutable* has had her engine transformed into a triple-expansion engine, the 27.44 centimeter guns of her redoubt replaced by 24 centimeter guns, the 13.86 centimeter guns of her battery by 10 centimeter guns. In four years she is to be supplied with multitubular boilers.

The *Dévastation* has already had several changes made in her armament, and in a few months will be provided with new boilers.

The *Courbet* is to have her armor changed without delay at Brest. Her boilers are still almost new and will not be replaced by water-tube boilers for several years.

It would be desirable in the case of these three ships that the guns of large caliber be retained in the redoubts only. Those of the deck without any protection could be advantageously replaced by 16.47 centimeter rapid-fire guns, and the consequent saving in weight might enable them to be protected somewhat.

The *Formidable* and the *Baudin* have already undergone a first transformation of their armament. The 37 centimeter gun has given place to four 16.47 centimeter guns in two casemates protected by 10 centimeter armor plate. A second period of transformation will consist in the replacement of the 37 centimeter fore and aft guns by 27.44 centimeter guns 40 calibers long, the saving in weight enabling them to be placed in closed turrets. Perhaps it would be better to provide the fore part of the ship with a light armor above the armor belt.

On the *Duperré* the 34 centimeter gun, of which the zone of fire is ridiculous, will be replaced by 16.47 centimeter R. F. guns, as in the case of the *Formidable.*

We now come to four much more recent battleships of the type *Hoche, Marceau,* etc.

The *Hoche* is undergoing thorough transformation. Her admiralty boilers are being replaced by Belleville boilers; her superstructures are reduced as much as possible.

The *Hoche* is the only battleship older than the *Brennus,* which has the upper works slightly armored forward as far as the pont de la plage.

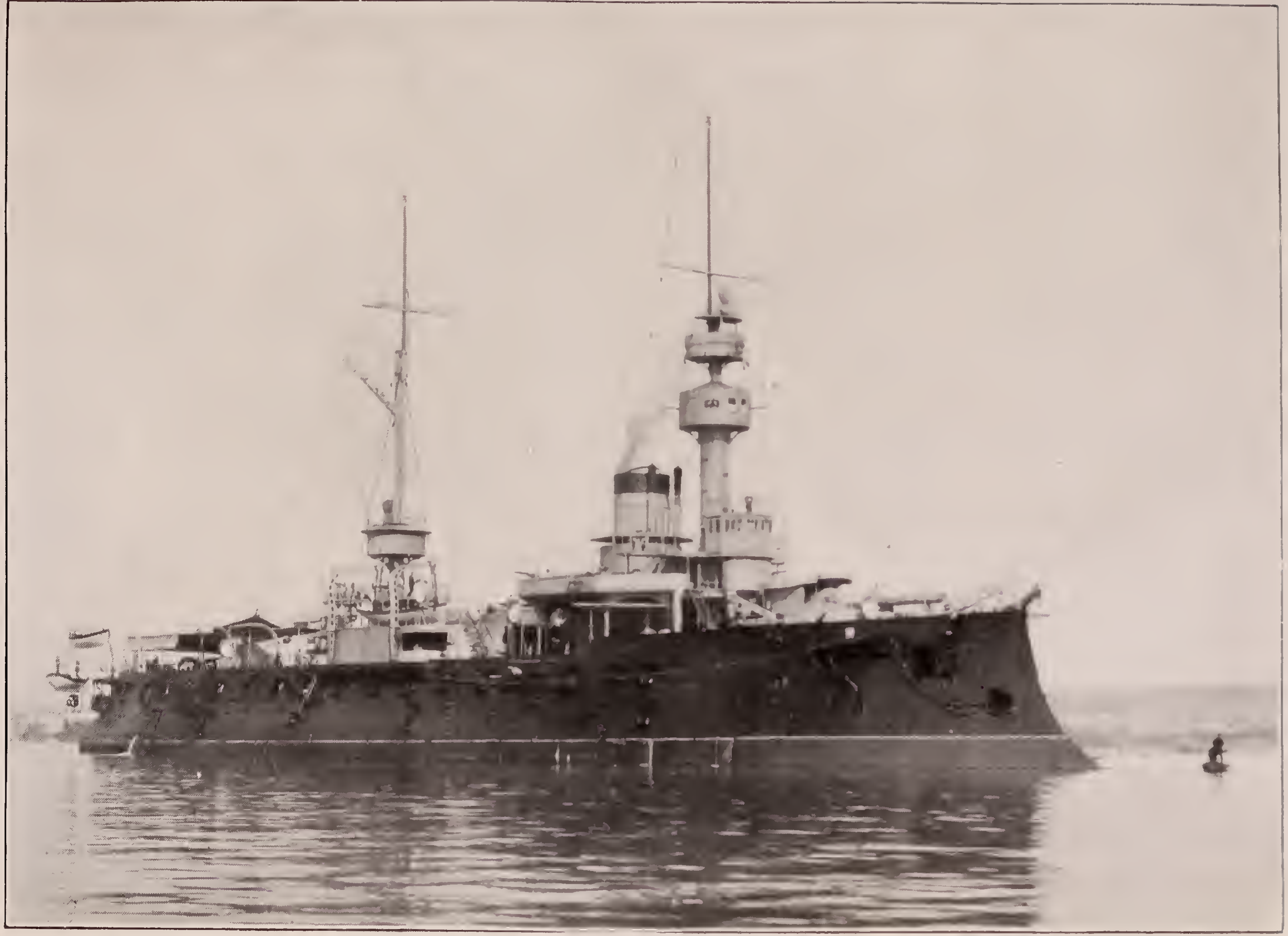
The *Neptune,* which resembles a high fortress, is to be sent from Toulon to Brest this winter. Her superstructures are to be diminished and her boilers changed.

The *Marceau,* although less burdened with superstructures, will also have part of them removed this winter. She is to be provided with Niclausse boilers.

Finally, there is the *Magenta,* which later on, in two or three years, will have her boilers changed, and her superstructures are also to be removed in the near future.

In regard to our coast-defense armorclads, a reduction in the armor is especially evident. Different plans have been taken under consideration—namely, to taper the armor plates, pierce them with holes in places, or remove part of them. Whatever expedient is resorted to, the weight of our coast-defense vessels must be decreased. They are all to have their large-caliber guns changed—those of 42 centimeters are to be replaced by those of 27.44 centimeters. At the present time the *Requin,* which is being furnished with Niclausse boilers, is undergoing a thorough remodeling. Similar work is about to be begun on the *Indomptable,* and the two others will take their turn afterwards. Lastly, the *Furieux* is also to undergo a similar remodeling.

When all this work is completed our second-class battleships will,



AMIRAL BAUDIN. (Battle ship, since her transformation.) 11,723 tons; I. H. P. (nat.), 5,000; speed, 14 knots; launched June, 1883.

beyond doubt, have materially advanced in military value. The outlay made will not be lost. In this connection we express the desire that the unprotected torpedo launching tubes, especially dangerous in themselves, be abolished; that on all battleships having more than four guns of large caliber the surplus of such guns be replaced by protected rapid-fire guns of medium caliber; that upon the battleships having batteries, such as the *Formidable* and *Neptune*, the endeavor be made in so far as possible to utilize the resultant saving in weight in favor of light armor for the upper works over a certain length of the fore part of the ship similar to that on the *Hoche*. An armor of special steel 4 or 5 centimeters thick would be a decided improvement.—*Le Yacht, September 23, 1899.*

FRANCE.

DOCKYARD WORK.

The removal of some of the armor-belt from the coast-defense ship *Indomptable*, and the substitution of 27.8 centimeter (10.8 inch) guns for her 42 centimeter (16.5 inch) guns, is now being carried out at Toulon. The work was originally ordered to be taken in hand more than a year ago, but there have been some extraordinary delays.

At Brest the work of substituting 10.8 inch guns for the 12.6 inch guns in the *Courbet* and *Dévastation*, which has long been talked about, is at last to be carried through this winter. The new guns are 45 calibers long, about 41 feet, and some curiosity is felt as to how they will be placed in the redoubts, as the old guns they are replacing are some 12 feet shorter. The new guns are much more powerful, as they have an initial velocity of 2,625 foot-seconds, against 1,804 foot-seconds in the old pattern, with an initial energy of 22,750 foot-tons as against 17,000, the weight of the projectile being 476 pounds in the new gun against 760 pounds in the old, while the weight of the guns is 35 and 42 tons, respectively.

GERMANY.

The third-class battleships *Baden*, *Bayern*, *Sachsen*, and *Wurtemberg* have been extensively overhauled and remodeled; screws, boilers, and engines renewed, and the armament modernized, though the six 26 centimeter guns are retained. The woodwork has been removed and replaced by metal. The weight has been lightened by 300 tons. One large funnel, instead of four; one military mast. New conning tower forward, protected by hardened nickel.

The *Baden* was rebuilt by the Germania Works, Kiel.

The *Bayern* was rebuilt by Schichau, Danzig.

The *Sachsen* was rebuilt by the Imperial Works, Kiel.

The *Wurtemberg* was rebuilt at Wilhelmshaven.

The trial results after remodeling are as follows:

Baden.—April 15, 1898; 17 knots with 6,000 I. H. P., and 17.3 knots with 6,200 I. H. P.

Bayern.—In the fall of 1898; 15.5 knots with 6,386 I. H. P.

Sachsen.—May 1, 1897; 14.5 knots with 5,940 I. H. P.

The armored coast-defense vessel *Hagen* is undergoing a modification which is probably entirely new in the art of naval construction. The imperial marine office intends to lengthen the *Hagen* considerably, although she has an armor belt of 24 centimeter thickness. The space thus gained is to be utilized for enlarging the coal bunkers, thereby giving the vessel a greater radius of action. Hitherto the coal supply amounted to 250 tons, permitting the vessel to steam 2,000 miles. The length of the *Hagen*, which is now 73 meters, is to be 80 meters after the reconstruction. At the same time the rapid-fire armament is to be increased, so that the fighting efficiency of the armorclad will be materially heightened by these modifications.

ITALY.

ITALIA AND LEPANTO.

These Italian battleships, of 14,000 tons, are to be stripped of their armor and converted into cruisers. The gain by removal of armor will be utilized in coal stowage; and the new bunkers, 16 feet wide, will afford great protection to the machinery. The *Italia* was built in 1880, and the *Lepanto* three years later, and they were very speedy ships. Converted into cruisers, their four 100 ton guns will be removed and four 10 inch and a number of quick firing 6 inch guns will be substituted.

6. ICE-BREAKING STEAMERS.

During the spring of 1899 the ice-breaking steamer *Ermack*, by her wonderful work in conveying into Russian ports on the Baltic a large number of ice-bound vessels, suggested the possibilities of this class of craft as a factor in naval affairs. Although the pioneer ship *Britannia* of the Cunard Line, on account of an experience with ice in Boston Harbor in 1844, lays strong claim to the honor of being the first ice breaker driven by steam, the first steam vessel especially built for this purpose appears to have been the *Pilot*, belonging to the port of Cronstadt. She was a small single-screw tug, having very sharp lines and great rise of floor, and fitted with a bow fashioned in such a way that the vessel could be forced up on the ice, breaking it down by her weight.

The Hamburg authorities soon built similar vessels for the Elbe, such as the *Eisbrecher I*, of 600 I. H. P., in 1871, and the Scandinavian countries followed with ice breakers and ice-breaking ferry steamers, propelled by paddles and by single or double screws. The *Sleipner*, at Copenhagen, of 1,400 tons and 2,600 I. H. P., had the forefoot cut away from a point on the stem above the water line in a slanting direction, and striking the keel about one-fourth the vessel's length from the bow, thus naturally facilitating the mounting of the vessel onto the ice field.

The discovery was made in America that by going astern with single-screw steamers, the disturbance of the water by the propeller had a disrupting influence of an important character. Consequently, the *St. Ignace*, 1,200 tons, built in 1888, and the *St. Marie*, built in 1893, for service on the Great Lakes, were each provided with a bow propeller. The *Sampo*, built for the Finnish Government, of 2,000 tons and 3,000 I. H. P., has one propeller aft and another forward, and her chief dimensions are: Length, 202 feet; beam, 43 feet; depth, 29 feet 5 inches. Her contour is such as to strike the ice at a very acute angle, so that when the vessel is driven with considerable force she has a tendency to rise on the ice in a slanting position, which, while it conduces to bringing her maximum weight to bear, does so in a manner which mitigates the blow to the vessel herself.

Near the town of Saratoff, on the River Volga, a ferry steamer with four lines of rails for railway cars not only contends with ice but with varying heights of water; she is assisted, moreover, by an ice-breaker of the ordinary type. There is now also under construction on the shores of Lake Baikal a vessel of 4,200 tons, 290 feet long, 57 feet beam, and 28 feet 6 inches deep to the rail deck, designed to ferry the Siberian railway cars a distance of 40 miles. The *Minto*, an ice-breaking steamer, built by Messrs. Gourlay Bros. & Co., Dundee, for the Canadian government's winter mail and passenger service between Prince Edward Island and the mainland of Canada, has recently (August, 1899) made her trial trip on the Tay, attaining a speed of 16.25 knots. She is 225 feet long, 32 feet 6 inches beam, and 20 feet 6 inches molded depth, fitted with water ballast in cellular double bottom and in large deep tank to 'tween deck aft, for giving her the proper ice-breaking trim.

Fully three times as powerful as any vessel previously constructed, the *Ermack*, designed by Vice-Admiral Makaroff, of the Russian imperial navy, and built last year in England by Messrs. W. G. Armstrong, Whitworth & Co. for the Russian Government, deserves particular study, by reason of the novel features in her construction. Her principal dimensions are as follows: Length, 305 feet; beam, 71 feet; depth to upper deck, 42 feet 6 inches. At no point are the lines of her hull straight, thus assisting in disengaging her from fields of ice when there is danger of her being frozen in. This form of hull and the great strength of the structure would result in the ship being lifted bodily rather than giving way, in case the ice closed about it. The strength and rigidity of the hull are so great, in fact, that if the ship should be suspended by the bow and stern without any intermediate support no damage could ensue. The heavy web framing and the plating of the ice belt, extending entirely around the hull, like the armor of a modern war ship, with a maximum thickness of 1¼ inches, render the outer skin impregnable to attacks of ice.

The *Ermack*, like her early precursor, the *Pilot*, has her bow designed with a very long overhang, so that the attack on the ice takes the form of a sliding blow, and if the resistance encountered is more than sufficient to overcome the breaking strain thus produced, the momentum of the vessel is expended in lifting the bow on to the top of the ice; meanwhile the water supporting the ice is violently disturbed by the action of a propeller arranged under the cutaway bow, so that under the effect of the weight of the vessel acting above and enhanced by absence of support below the ice gradually yields. The action thus described will take place continuously when working in thick ice. The foremost part of the bow is composed of a solid steel casting. Three screws are placed at the stern, one being on the center line as in ordinary single-screw vessels and the other two as in the usual twin-screw arrangement. The four screws are arranged so that large blocks of ice may be carried clear of the hull or out of the way of the advance of the vessel by means of the current or race due to their working. It is hardly necessary to say that an ice-breaking steamer, to be effective, must have remarkable manœuvring powers, as vessels working in frozen seas have the very smallest space to turn in at times. For this reason the twin-screw arrangement was desirable, but with twin screws the efficiency of the rudder may be lessened, as the propeller race is not thrown directly upon it, as is the case with one screw working directly forward of the rudder. The bow screw is not introduced for speed purposes, but simply to enable the ship to clear her way and keep lumps of ice from accumulating under her bottom. All four propellers are four-bladed, made of nickel steel, and enormously thick, being calculated to be brought up by ice without breaking when running at full speed. The machinery is all designed to withstand this test.

The vessel is divided into 48 absolutely water-tight compartments, of which 14 are in the double bottom. There is one cross bunker for coal, as well as side bunkers. The fore and after peaks are arranged for trimming purposes, so as to bring the vessel by the head or stern with water ballast. There are also two heeling tanks amidships. In case the ice crowds the ship on one side, the tank on that side can be filled and an extra pressure of some hundreds of tons brought to bear on it so as to right the ship and crush the ice down into the water. Both tanks would be filled if it were found that the ice was raising the ship bodily. The weight and shape of the *Ermack* would make her roll considerably in a sea way, and she can not have bilge keels, since they would afford a grip hold for the ice; therefore she has also been provided amidships with a third or antirolling tank. Connected with these tanks are pumps of enormous power, so that if the vessel gets caught in the ice her horizontal plane may be varied in any sense desired, whereby she can the more readily release herself. The pump room is a well perfectly water-tight, let into the middle of the vessel and descending to within 7 feet of the bottom. The salvage pump has a capacity of 10 tons per minute, and if the ship were flooded above the level of this pump the latter would be still accessible. The ballast pump is arranged so that it can take hot water from the boilers and pump it into the fore peak, the hot water overflowing through valves in the bow and running down the outside of the skin plating. This is designed with the purpose of preventing rough ice from adhering to the hull.

At the stern the vessel is shaped much like a cruiser, but instead of being rounded off has a deep groove, furnished with fenders, intended to receive the stem of another steamer of the ordinary type in conducting her safely through the broken ice. By means of a powerful winch the second steamer may be braced up taut, and thus be enabled to add her power to that of the ice breaker in struggling with the ice.

Another interesting feature is the so-called ice box, an open tube amidships from the main deck down to the water under the ship's bottom. Through this the boilers are fed with water direct from the sea beneath. This tube is connected with a glass pipe set against a wooden scale on which are marked on one side the number of feet that the vessel is drawing, and on the other the number of tons which the ship displaces at that draught. The total displacement of the *Ermack* is 8,000 tons; indicated horsepower of the engines, of which there is a set of the triple-expansion type to each propeller, 12,000, giving a maximum speed, it is understood, of 16¼ knots. The results of the steam trials showed that the speed with 8,000 I. H. P. was nearly 15¼ knots.

Experience with the *Sampo* and *Ermack* has shown that pack ice of practically any thickness can be negotiated, and in the case of the latter vessel, she on one occasion encountered a pack which was measured and found to be of a total thickness of 34 feet, 9 feet being above the level of the field, and through which she successfully forced her way, a feat which would have been quite impossible but for the action of the forward propeller. The *Ermack* has broken composed ice of 8 feet 3 inches in thickness, and she has gone through field ice of about 40 inches, with 6 inches of snow upon it, at a speed of 2.5 to 3 knots; moreover, she has been driven at a speed of about 10 knots through clear ice of 24 inches, while ice under 18 inches has little effect upon her. It is found that snow has a wonderful retarding influence upon an ice breaker, much more so than a similar thickness of solid ice.

Her manœuvering powers are remarkable, seeing that with her helm only she can turn in a circle of only twice her own length; and her handiness was specially shown when she entered the frozen-up port of Cronstadt on March 16 last, proceeding without stopping through an entrance only 95 feet wide, and berthing herself alongside the quay without assistance, whereas under ordinary circumstances of navigation in open water steamers are in the habit of invariably being assisted by tugboats.

Her practical utility was not long in being put to the test. Immediately on her arrival urgent word was received from Reval that a number of steamers were in great jeopardy. She at once proceeded there, and was the means of liberating 33 steamers, of an aggregate value of $7,500,000. She subsequently returned to Cronstadt and St. Petersburg, and was instrumental in relieving and facilitating the entry of some forty more steamers several weeks earlier than if they had waited the ordinary opening of navigation. The above performance is a very conclusive proof of the commercial value of such a vessel.

As a factor in naval operations it is not difficult to estimate the possibilities of a vessel like the *Ermack*. It looks as if the Russian fleet can no longer be considered as ice bound when wintering in the Baltic ports of Vladivostock—a fact of very considerable importance in the event of Russia finding herself engaged in a naval war. Moreover, the vessel itself would be distinctly formidable as a ship of war. As a ram she would be a deadly weapon of offense if she once got her blow home, especially on a ship with a low freeboard, for she would bear her down by her overwhelming weight until she filled and sank, while the *Ermack* herself would be invulnerable as long as her engines and boilers, which are excellently protected, were intact.

It is stated in a recent report (September 23, 1899) that the "*Ermack* has just finished a two weeks' trip to the northwest of Spitzbergen. She passed through about 200 miles of ice, and its thickness is estimated at about 14 feet. The ship performed the task without injury."

According to latest advices (October 19, 1899) the *Ermack* is shortly to take up a more important work than ever. This is to keep navigation open during the coming winter, not only between St. Petersburg and Cronstadt, a distance of 20 miles, but also as far as Reval and Libau on the Baltic. If the *Ermack* succeeds in keeping the Gulf of Finland and the Baltic open to navigation the shipping trade of St. Petersburg will be greatly affected thereby. Hitherto the shipping trade of the capital and Cronstadt has been impossible for about six months every year. During the winter a certain amount of trade is carried on by rail to those Baltic ports which happen to be open to navigation.

7. PRESERVATION OF MODERATE TEMPERATURE IN MAGAZINES.

DEVELOPMENT IN FRENCH NAVY.

A ministerial circular, dated July 23, 1888, had particularly in view the isolation of powder rooms or magazines with respect to the fire rooms. As far as possible magazines were to be separated from fire rooms by coal bunkers of suitable thickness; in default of these the partitions of magazines contiguous to fire rooms were to be made double. Special tubes, independent of the general system of ventilation, were to insure a supply of fresh air and the removal of warm air from each magazine as well as from the space between the two partitions of the walls. In case of insufficient natural ventilation, ventilators *á bras* were to be provided.

During the time of the adoption of these precautions the question had been under discussion as to the means to be employed in order to prevent an abnormal rise in the temperature of magazines, and specially long thermometers were officially furnished to assist in regulating the temperature. In consequence of this discussion a ministerial circular, of November 21, 1893, fixed 35° C. (95° F.) as a limit of temperature not to be exceeded in magazines. The observation was made that the adoption of this number (35°) would avoid, in many cases, recourse to special apparatus, such as refrigerating machines or ventilators, for the cooling of the magazines, the results ascertained upon certain ships having given recent occasion for the belief that it would be possible to maintain the temperature of magazines below this point merely by constructing these magazines in accordance with the provisions of the circular of July 23, 1888. The example furnished by the ship *Neptune* appeared conclusive in this regard.

The installation of refrigerating machines of various kinds on board the ships of the fleet, moreover, was under consideration, with a view of preserving in the magazine a temperature constantly below 35° C.

Machines of this kind were installed on board the *Admiral Duperré*, and in one or two other of the French cuirassés. The principle of the apparatus may be briefly stated as follows:

Air, compressed in a compressing cylinder, leaves it at an increase of temperature proportional to the degree of compression, and is then made to pass through a tubular refrigerator, in which its temperature is lowered nearly to that of the sea water used in the cooler. From this the air passes to a cylinder, in which it is expanded, and in which, conformably with the laws of thermodynamics, its temperature is lowered in a degree proportional to the degree of pressure to which it has been subjected. In this operation it produces a mechanical work, which is utilized to reduce the power necessary to run the machine or motive force. The air issuing from the expanding cylinder is then conducted to the magazine which it is desired to cool.

The engines used in the apparatus are of the ordinary commercial overhead vertical type, and the circulating pumps are also of commercial types.

The dense-air system is preferred to those involving chemical processes, for reasons the more obvious in use on shipboard.

The *Henri IV*, a modification of the d'Entrecasteaux or Dupuy de Lôme type, is provided with refrigerating machines for cooling the magazines. Refrigerating machines, for cooling the magazines, have been introduced on the *D'Assas*, *Du Chayla*, and *Cassard*. In the after dynamo room (of the *Cassard*) is placed the refrigerating apparatus for cooling the magazines. It is on the ammonia-gas principle. There are some doubts as to its efficiency, since it is reported that all previous plants installed have worked badly. The cooling pipes in the magazines are of brass and fixed to the ceiling. They are about 1¾ inches in diameter, and spaced about 8 inches apart, covering two-thirds of the area of the ceiling.

Pothuau.—Magazines, three sets on this ship, situated forward and abaft the boiler and machinery spaces and between the after boiler room and the engine room. The forward and after magazines are ceiled with linoleum glued to the side walls and stretched along the beams overhead. The middle magazines ceiled with asbestos on bulkheads and with planking laid over the framing angles. Refrigerating machines provided for cooling the magazines to a temperature below 32° C. (90° F.).

Protet.—To prevent high temperatures in the magazines, refrigerating machines are to be installed so that under no condition of fires under the boilers shall the temperature of the magazines exceed 35° C.

Refrigerating machines for magazines.—A number of these machines are being introduced in French ships. The *Baudin*, *Redoutable*, and *Duperré* have them. The machines deliver the air in the magazines reduced in temperature as much as 30° C. (86° F.), if desired, below the temperature of the air received at the machine.

Method of cooling in some of the French vessels.—In the Mediterranean Squadron almost all the magazines are kept sufficiently cool by a current of air from small electric blowers, two blowers being usually fitted to each magazine. With few exceptions, however, the ships are also fitted with frigorific machines, which in case of necessity can be used to lower the temperature in very hot climates or when continuously under steam.

The following method has been used with success on some of the vessels, particularly the older battleships. The outside of the magazine is covered with canvas held against the metal bulkhead by light battens of wood. Around the upper edge of the bulkhead is a small pipe pierced with numerous holes. This pipe brings sea water by gravity, and by an ordinary cock can be regulated so as to keep the canvas always wet. The surplus water from the canvas is caught in a small trough or gutter fitted around the bottom of the bulkhead and conveyed through a suitable pipe to the bilge. This method, like the others, is of course only used in case of necessity, and it is described by French officers as being very efficient.

In refrigerating apparatus (other than dense air) the liquids most employed are ether, ammonia, sulphuric acid, carbonic acid, and methyl chloride.

Low temperature of the magazines of the *Royal Sovereign* (English navy) was maintained at 70° F. during her trial trips, although situated between the engines, amidships. This was accomplished by using a thickness of silicate of cotton in the bulkheads and an air space.

8. AUTOMATIC DEVICES FOR OPERATING WATER-TIGHT BULKHEAD DOORS.

Attention has recently been focused upon the subject of water-tight bulkhead doors, and particularly upon methods of automatically closing them in the event of a sudden inrush of water into any compartment. Several serious marine accidents, it appears, might have been averted by the application on the unfortunate vessels concerned of some device having this end in view. Of late years a variety of such devices has been brought forward deserving of careful consideration by naval authorities. The main requirements of a satisfactory apparatus of this nature are: (1) Simplicity and fewness of parts, involving lightness and avoiding bulkiness; at the same time, however, (2) strength to restrain huge masses of water, which may be in violent motion from the rolling of the ship; (3) ease and certainty of action; (4) ability to crush through or throw out of the way whatever obstructions happen to be in the opening; (5) capability of being operated from the bridge or engine room, and (6) unobstructed opening when door is opened (at least in places where material or stores of one sort or another are continually being carried from one compartment to another).

Among the later appliances put on the market the following appear to fulfill, in most respects, these stated conditions:

MONTGOMERY-MOORE SYSTEM.

(See Plate I.)

It is reported that the French minister of marine and chief constructor has concluded that "this system of controlling water-tight doors is most advantageous, and contributes a very desirable safeguard." The plans were approved and referred to the firm of Messrs.

Sautes & Hasle, as to "their adaptation to electricity instead of hydraulic power," with the result that a contract has been signed.

The system was previously to this successfully tested on board the London-Bordeaux packet boat *l'Hirondelle.*

Water-tight bulkhead doors, whether sliding or hinged, are, in the application of this system, governed by two hydraulic pistons, one carried on each side of the door. One acts to keep the door closed, the other to resist this action. In the latter, the pressure, being stronger, holds the door open for service, but if this pressure be diminished, the other piston comes into play and closes the door, the joints of which are furnished with felt, oakum, or some other material to prevent leakage.

To obtain automatically this diminution of pressure at the moment of an accident, tubes conducting water or some other fluid, destined to compress the piston for opening the door, are disposed in such manner below the water line, entirely around the ship, fore and aft, that it is impossible for any rupture of any part whatever in the skin of the ship to occur, when produced either by collision or by running aground, without these tubes being broken; thus their pressure is no longer exerted, and that piston works unrestrainedly which causes the door to close.

This system also provides for the control of all the doors by means of a hand lever in the immediate vicinity of the officer in command. This lever is connected with gear extending to each of the doors, so that a single movement will cause any or all of them to close or open. This may be done either by water, air, or electricity. In every case means are provided for sounding an alarm before closing the doors, and the closing of the doors is automatically shown on an indicator board in the vicinity of the lever. The doors are closed automatically in case of sudden and unforeseen collision, and by key in cases where danger is apprehended or, as in bulkhead door drills, when men are at stations preparatory to action.

This system is applicable to most if not all kinds of bulkhead doors.

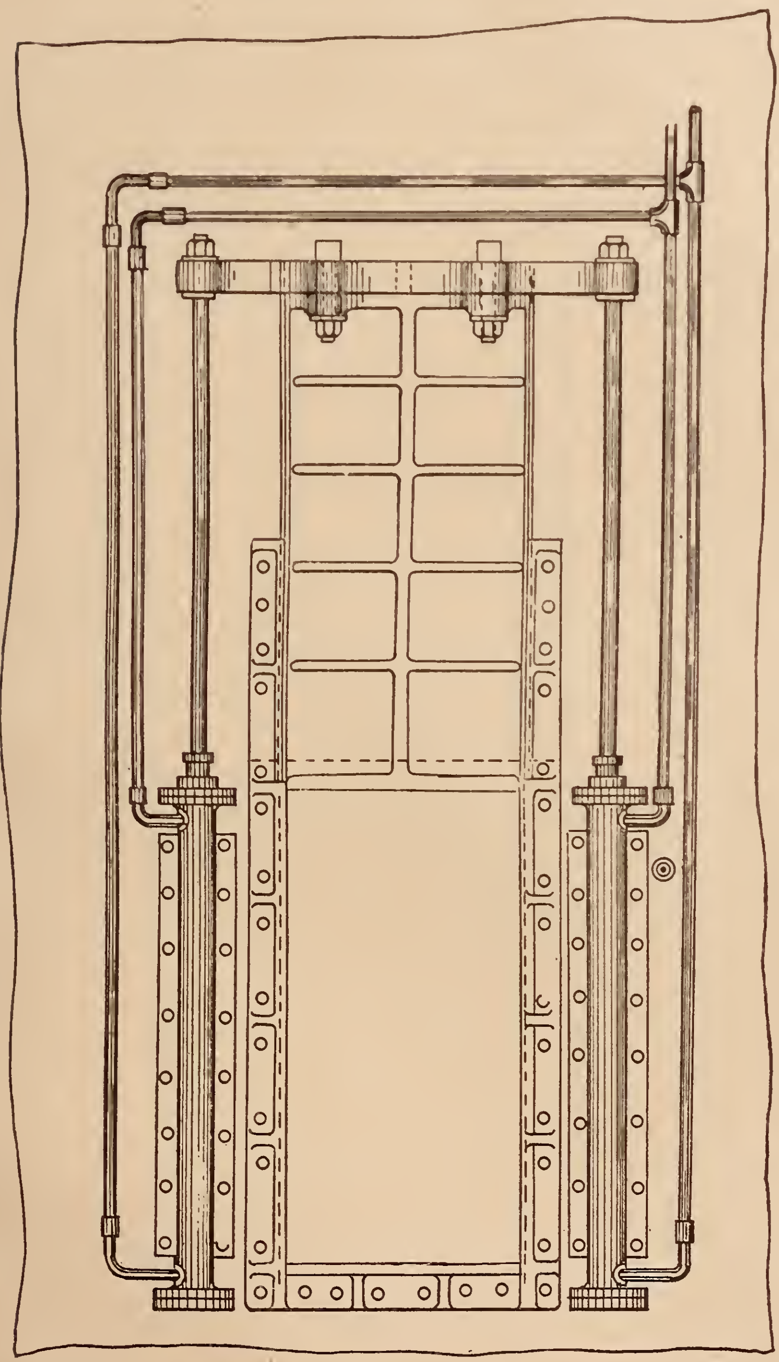
CRAWFORD'S PATENT WATER-TIGHT BULKHEAD DOOR FOR SHIPS' HOLDS.

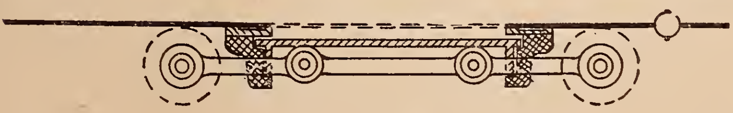
(See Plate II.)

In the accompanying drawing illustrating the working of the door, it will be observed that it is shown open.

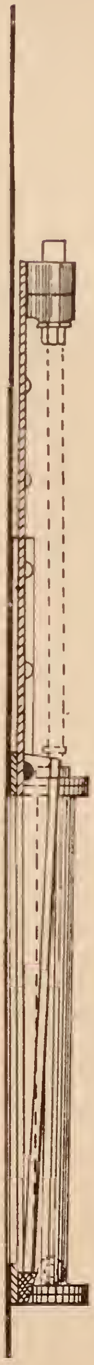
In the event of an accident the inrush of water into a vessel's bilges enters the galvanized iron air vessel or chamber A fixed in the vessel's bilges; the compression of air in the chamber A, caused by the rising water, is carried up a small copper pipe B leading to and actuating upon an elastic metallic diaphragm C, provided with a pin D, which in its turn forces the lever E into action, thereby withdrawing the clutch F; the door G now being free falls by its own weight.

SLIDING WATERTIGHT DOOR. (DOOR OPEN).

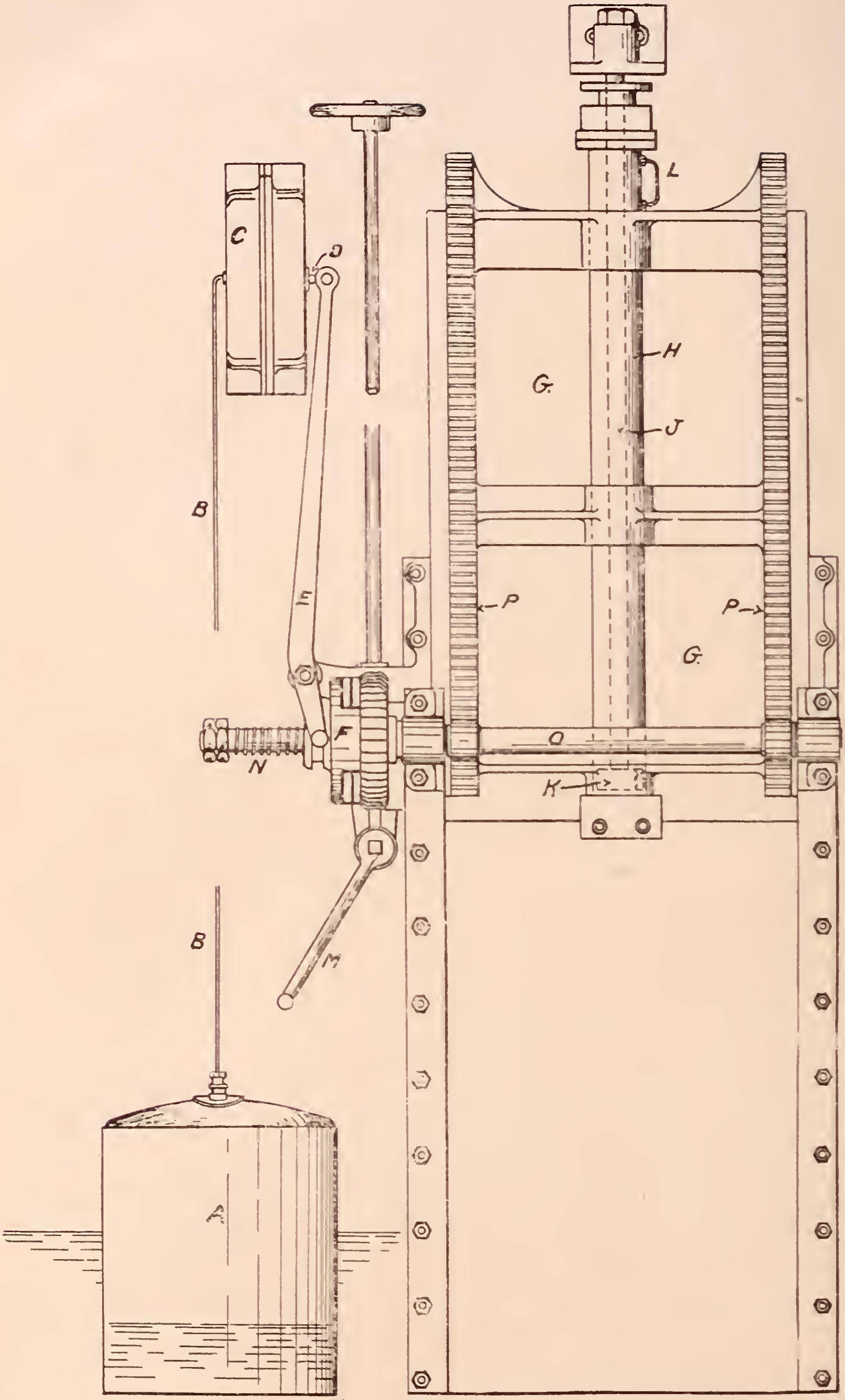




SECTION AT TOP.



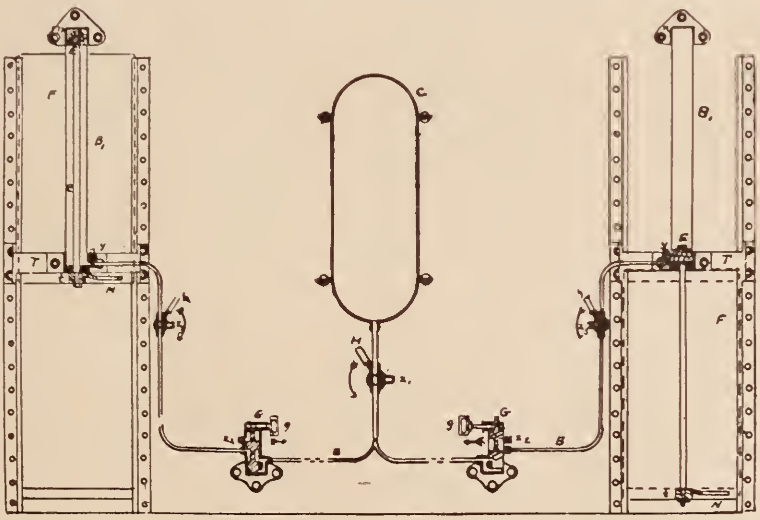
SIDE SECTION.


L
C
D
H
G
J
B
E
P
P
G
F
O
N
K
M
B
A

To the door G is attached a cylinder H filled with oil, fitted with stationary piston rod and piston J, secured to the bulkhead at its upper end, the piston K, having hole bored through the same, the size of hole regulating the speed at which the door falls. A by-pass pipe L, fitted at the top of cylinder H, or enlargement of diameter of cylinder, permits of the easier passage of the oil to the other side of the piston, thus allowing the door to fall sharply into its closed position when about 6 inches from the bottom.

The object of this retarded motion in the falling of the door, as above described, is to minimize the risk of life and limb so often endangered by the sudden sharp fall of a heavy door, and also to give the crew inside a chance of effecting their escape.

While the door is being raised by means of a portable handle or wheel M, the powerful long spring N immediately presses the clutch F into position, thereby putting into action the horizontal shaft O, thus raising the door by means of the ratchets P.



Although the special feature of this door is its automatic character, the door can be operated by hand from the deck, or otherwise if desired. This arrangement also can be adapted to existing doors.

APPARATUS FOR OPERATING BULKHEAD DOORS INVENTED BY HERR CARL T. DÖRR, OF OHLIGS, GERMANY.

An ingenious combination of hydraulic and air pressure is made use of, the arrangement being such that the doors may be closed either automatically upon the entrance of water, or from any desired station, such as the conning tower, or locally by the crew. In the example illustrated (a falling door) the weight of the door may replace one of the pressures named, but in the event of a sliding door, the lower half of the accumulator C is supplied with fluid, and the upper half with air-pressure systems of conduit pipes, branching throughout the ship from both halves of the accumulator. The compressed-air conduit leads to containers, and the liquid-pressure conduit B to cylinders B_1, the pistons E of which are connected to the doors F, an automatically or hand operated three-way escape valve G H *h* controls the motion of differential valves, which in turn control, respectively, the inlet and outlet of fluid or air pressure to the pistons, so opening or closing the doors as desired. A hand valve H is provided for each door, and by this means the crew can locally remove the pressure and so bring into action the differential valves referred to. The system seems to possess the merits of simplicity and fewness of moving parts.

WATER-TIGHT DOORS, CLOSED AUTOMATICALLY OR BY HAND, INVENTED BY MR. O'BRIEN, GLASGOW.

The feature of this patent consists of a bracket extending across the door and made fast to the framework at the top. This bracket is recessed for containing the worm for working the rack on back of door. In this bracket and at the top and bottom of the worm are placed eccentric bushes with a lever made fast. To this lever there is attached a connecting rod, the other end being connected to a bell crank fixed to the bulkhead, and to the other end of this crank is made fast another connecting rod extending downward to the bilge of the ship where it is fixed to a float, so that when from a collision or other cause the water gets into any compartment of a ship where this gear is fitted and rises high enough to lift the float, it at the same time pushes up the rod attached to it, by which action the position of the bell crank is altered and pushes the rod attached to the lever on eccentric bushes, moving them around in the bracket about a quarter of a turn, thus taking the worm out of gear with the rack on the door. Then the door immediately descends, but to prevent it from coming down too hurriedly and injuring the framework, there are two balance cylinders fixed, which allow the door to fall gently into its normal position.

For the purpose of putting all the water-tight doors under the control of the officers on deck, the automatic gear is connected to levers on the navigating bridge, so that the officers can manipulate the doors at will.

This gear is illustrated in Pl. III, of which fig. 1 is a front and fig. 2 a side elevation of the invention. Fig. 3 is a similar view, showing the apparatus when the door has been automatically closed into its normal position and the worm out of gear. Fig. 4 is a plan of the water-tight door with the bracket extending across the door for carrying the two cylinders. Those cylinders, with their pistons and piston rods, are to prevent the door from coming down too hurriedly; this bracket also carries the worm for working the rack, and also shows a plan of the automatic gear with the worm in gear, the rack and

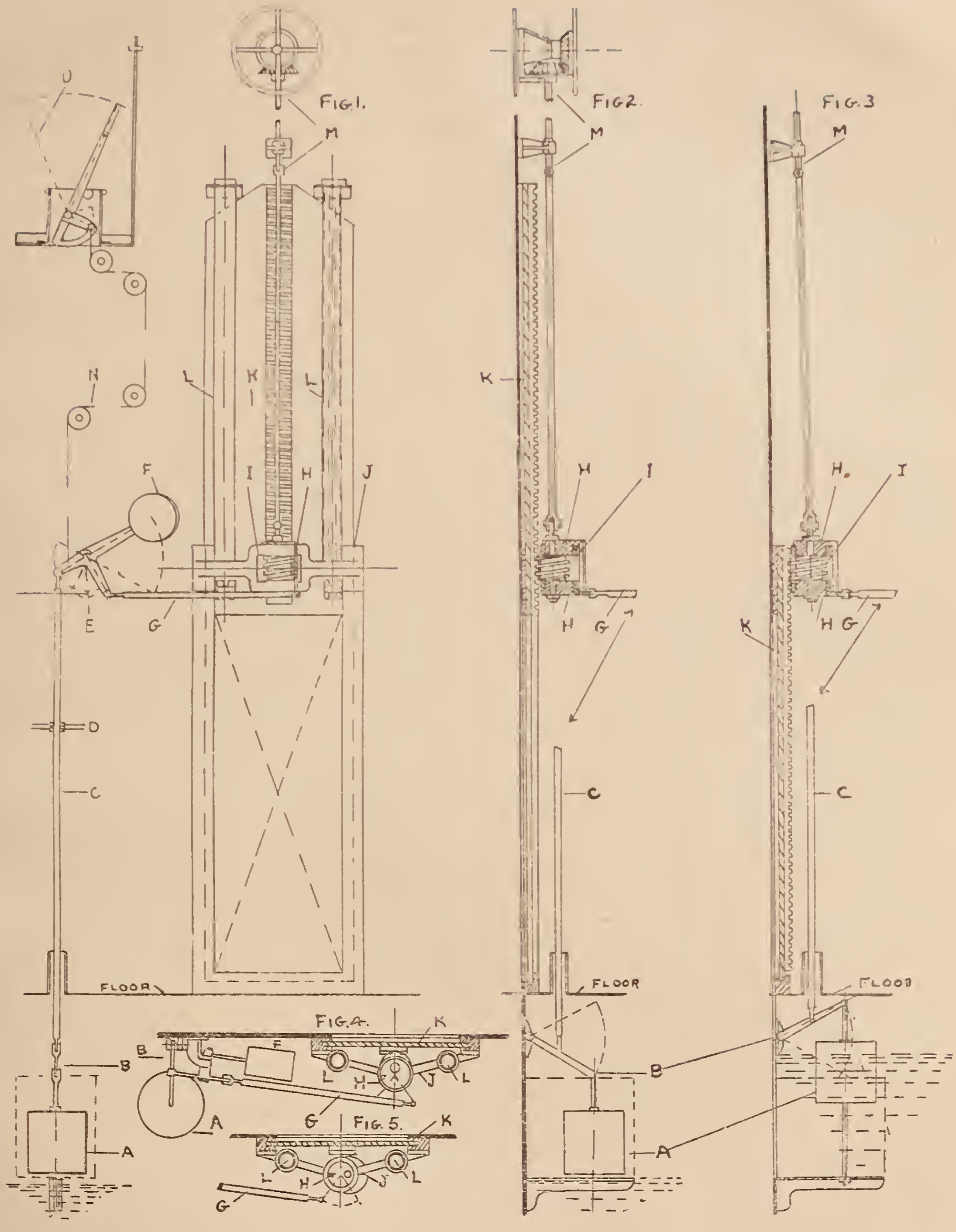


FIG. 1.
FIG. 2.
FIG. 3
FIG. 4.
FIG. 5.
M
L
K
L
N
F
I
H
J
E
G
D
C
B
A
FLOOR
K
H
I
H
G
C
FLOOR
B
A
M
H
I
K
H
G
C
FLOOR
F
B
L
H
J
L
G
K
L
H
J
L
G

the eccentric bushes in position. Fig. 5 is a similar view, showing the eccentric bushes in a different position and worm out of gear with the rack.

A represents the float placed in the bilge of the ship convenient to the water-tight door; B the lever connected to a rod made fast to the float, and which acts as a guide to the float; C, connecting rod made fast to bell-crank lever E, carrying balance weight F adjustable to take up the weight of gear; G is a connecting rod made fast at one end to the bell-crank lever E, the other end of which is made fast to lever I, connected to eccentric bushes H at top and bottom; D is a cross handle fixed on connecting rod C, and is an additional means for working the gear; J is a bracket extending across the door made fast to the frames of the door on which are made fast the two cylinders L; the piston rods pass through the bracket and are fixed to the door; K is a rack on back of door; M is the gear for working the door by hand; N a chain or rope working over pulleys connected at one end to bell-crank lever E, the other end being connected to hand-lever O, placed in any convenient position, so that the officer in charge can shut the doors of any compartment.

As some water-tight doors are fitted with a long screw and a nut made fast on the back of the door, to meet this method of fittings, and the requirements of those that may adapt them, the eccentric motion is here placed on a square shaft extending up the side the whole length of the door with the nut in halves placed in the bracket on back of door. The same operation as described above throws the two parts of the nut out of gear with the screw and the door immediately descends.

THE "LONG-ARM" SYSTEM.

The long-arm system for operating bulkhead doors has, during the summer of the present year, been put to a practical test under service conditions on board the U. S. flagship *Chicago*. In the course of a period covering over five months this vessel steamed 18,900 miles, and was at anchor fourteen times, much of the time in tropical waters. During this time the long-arm system was constantly ready for use, and faithfully and efficiently responded to every emergency test, as well as to the operating of each individual door. The only defects in the system discoverable in this trial was the deterioration of the leather washers with which the valves were packed, due, in all probability, to the excessive heat of the water in the pipes, which in the *Chicago* are led directly over the boilers. The brief description which follows will serve to show the essential features of the system. It will be observed that it is not automatic in action in case of the sudden inrush of water into a compartment, differing in this respect from the other devices mentioned in this article.

The system may be said to be a three-part combination, the first or primary system being one which will allow of a series of mechanical devices, situated at a distance from the operating point, to be operated simultaneously, the second system allowing the operation to be carried out through a single main pipe in which a predetermined pressure is maintained, while the third provides means for operating each door independently.

A fluid-pressure accumulator has a steam cylinder and a ram, and forms the central station. Steam is supplied to the cylinder through a pipe provided with two reducing valves, the first being set to reduce the pressure to a predetermined point, and the second to reduce the pressure to about one-half of the first. Accumulator pumps are supplied with steam through a pipe leading from the interior of the steam cylinder, these pumps, when in operation, being supplied with fluid which they force into the ram cylinder, whence it is again forced through a distributing main and its branches to the bulkhead doors. A branch pipe leading from the first pipe mentioned between the two reducing valves to the second pipe mentioned, serves as a by-pass. A six-way valve placed in the conning tower is operated by a lever, causing the power cylinder to open a valve, thus throwing double pressure into the main and so closing all the doors.

The bulkhead doors slide vertically in guides fitted on either side with special arrangements for self-tightening on the door seats. To each door is fitted a cylinder having within it a hollow piston from which a hollow piston rod extends through the upper cylinder head. Within this hollow piston rod is a smaller pipe, leaving an annular space between the inner and outer pipes, which we will call, respectively, A and B. Two pipes *a* and *b* convey fluid pressure to the cylinder on the door, the pressure from one of these pipes passing to the inner; that from the other to the outer pipe in the cylinder. Thus if pressure be admitted to *a* by means of an operating valve, it will pass through A, forcing the cylinder down, and so closing the door. On the other hand, if pressure be admitted through *b*, it will enter the cylinder above the piston and raise the door. A hand pump is also fitted, which may be used to force the fluid from a reservoir (beside the door) to the cylinder, when it is required to open or close the door by hand power.

9. MARINE CASUALTIES.

ENGLAND.

The *Sans Pareil*, first-class battleship, a flagship during the naval manœuvres, ran down and sank the sailing schooner *East Lothian* in the English Channel, off Land's End, on the night of August 9.

On the 11th of October the *Anson*, lying at Gibraltar, was run into by the Orient Line steamship *Cuzco*, which was carried onto the bows of the *Anson* by the tide. The *Cuzco* struck the battleship on the starboard bow, cutting a large V-shaped hole near the anchor bed about 6 feet above and 3 feet below the water line. It was a clean cut through two decks. Collision mats were placed over the hole, and Captain Wilson, of the *Anson*, putting on a diving suit, personally examined the damage below the water line. A large quantity of water got into the foremost storerooms and compartments, causing the vessel to rise considerably at the stern. The *Cuzco* was damaged on both bows above the water line. Both ships went into dock for temporary repairs.

On the afternoon of January 23 the *Collingwood*, battleship, while proceeding up Plymouth Harbor behind the *Benbow* and the *Colossus*, appeared to lose her course and rammed the cruiser *Curacoa*, which was anchored apparently well out of the way of navigation. Several plates on the starboard side of the *Curacoa* were badly strained, and arrangements were immediately made for docking her. The deck fittings on the starboard side were greatly injured, one of the boats was swept from the davits, and others were damaged. The most serious injury was abaft the sponson of a 6-inch gun, where a large rent was made in the plating, through which a great inrush of water flooded several compartments. Immediately after the collision occurred the water-tight doors and the deadlights over the side scuttles were closed and collision mats were got out, but a great deal of water was nevertheless shipped. One of the water-tight doors became jammed, admitting much water, and it is supposed that the inrush of water displaced a quantity of small coal, thus causing an obstruction. The *Collingwood* was under easy steam at the time of the accident, otherwise the consequences would no doubt have been more serious.

H. M. S. *Narcissus*, an armored cruiser, which left Hongkong April 1 for Singapore and home, returned to harbor the next morning, owing to the bursting of a discharge pipe. The water got into her coal bunkers.

The *Terrible*, first-class cruiser, left Malta for England on the 8th of March, and soon after she had put to sea one of the tubes of her Belleville water-tube boilers burst and two men were scalded, but not seriously. The ship called at Gibraltar, leaving there the 12th, and when some 800 miles from Plymouth one of the boilers on the port side was found to be giving trouble, and a stoker named Edward Sullivan opened the furnace door to ascertain the cause. At that moment one of the tubes of the boiler burst with a loud explosion, and the escaping steam and water blew the fire out into the stokehold. Four men were injured, fatally in the case of the stoker mentioned.

A subsequent inquiry revealed the fact that the chief cause contributing to these accidents was the free use of sea water and its leakage through the auxiliary feed sea suctions and condensers, and the defects are thought to be generally attributable to obstruction of circulation by sea salts and by accretions of foreign matters, and in some cases these causes may have been aggravated by failure of circulation or of water supply, all resulting in overheating. In all seven tubes were split open, two of which were comparatively free of salt deposits, but in all there was considerable corrosion, especially of the separating plates in the steam collectors, and accretions of iron oxides, sea salts, and other impurities have been found in various parts of the boilers. The nonreturn valves and their fittings for insuring circulation have also been much worn. The *Terrible* was fitted with welded tubes, which are not considered by the Admiralty so efficient as solid-drawn tubes.

The coroner's jury returned a verdict of accidental death in the case of the stoker and appended the following rider:

> After hearing the evidence the jury find that no blame attaches to the officers or men of the ship. The jury are of opinion that the cause of bursting was from a defective tube and recommend to the consideration of the authorities the discontinuance of the further use of welded tubes.

A casualty occurred to the first-class cruiser *Amphitrite* at Chatham on her arrival from the building yard of the contractors, Messrs. Vickers, Sons & Maxim, Barrow-in-Furness. The vessel had so much "way" on her when she entered the South Lock that the riggers were unable to bring her up as sharply as was necessary, with the result that she ran into the inner caisson and caused considerable damage. The noise of the collision was heard at a distance of a quarter of a mile. Nearly the whole of the *Amphitrite's* defense booms and sockets were damaged and twisted out of shape.

Much trouble has been experienced with the 20 knot cruiser *Niobe*. On being commissioned, last December, to relieve the *Blake* in the Channel Squadron the Admiralty directed that the *Niobe* was to undergo a program of coal consumption trials, including two runs of sixty hours' duration. A start was made with these in January, but each time the vessel went to sea she had to put back with machinery defects, principally with the reversing gear. After being in dockyard hands nearly a fortnight she again prepared to leave Plymouth Sound for a preliminary run, but before she had cast off from her buoy it was found that the engines were not working smoothly. An examination showed that the gland box attached to the piston rod of the high-pressure cylinder would not act.

At Gibraltar, on the morning of the 8th of May, the ship's company of the *Niobe* were startled by the noise of a loud explosion. At the same time smoke was observed bursting from the foremost stokehold. Investigation showed that in tracing and oiling the engine-room telegraph rods, which lead through the coal bunkers, two stokers had opened a reserve bunker, and though they left the door open ten minutes before entering, the naked light which they carried had caused an explosion by the ignition of the coal gas inside. An inquiry resulted in a finding that the men opened the bunker door without orders. A further result of the inquiry is that all this class of cruisers lack sufficient ventilation to their reserve bunkers, and that in consequence these bunkers are more or less in a normal condition of being full of coal gas.

Among the English cruisers of the second class two casualties have been reported. The *Arrogant* collided with a floating wooden stage when leaving Gibraltar, in April, doing some damage to the plates on her starboard bow, and the *Bonaventure*, on July 5, ran on an unknown submerged rock, with but 10 feet of water over it, in entering Korniloff Bay, on the northeast coast of Korea. The bow of the latter vessel was forced out of the water until her ram was nearly level with the surface and her stern submerged until her after scuttles were awash. Two or three attempts were made each day to haul her off, and she was gradually lightened by the removal of her guns, stores, ammunition, etc., until she floated, finally, on the 8th. Several compartments forward were flooded. Temporary repairs were at once made, and she was able to go to Nagasaki to be docked, whence she proceeded to Hongkong for further repairs, which it was said would cost from £6,000 to £10,000.

Three casualties occurred to third-class cruisers in the course of the year. A serious breakdown of the *Pegasus*, which left Sheerness February 28 for the southeast coast of South America to relieve the *Basilisk*, obliged her to put into Plymouth. Her condensers leaked very badly, and salt water in the boilers caused them to prime so much that off Cape Ushant the cruiser became quite helpless. For sixteen hours she was at the mercy of wind and tide. After temporary repairs to two boilers, however, she was able to reach Plymouth, as above stated, under easy steam. In view of this experience the Admiralty have decided that in future every ship in commission is to be supplied with a small chemical laboratory to test the water during its passage from the condensers to the boilers, so as to ascertain immediately when the condensers begin to leak and to let in salt water.

In May the boilers of the *Pelorus* were found to be defective. When steaming at high speed the joints and tubes of some of the boilers were found to be leaking; it became necessary at once to draw the fires, and prompt action averted a serious catastrophe and probable loss of life.

Details concerning the grounding of the *Pylades*, in June, on the Northwest Reef of Australia, are not obtainable beyond the fact, reported on June 28, that a tug had gone to her assistance, and that all efforts had so far proved unsuccessful.

Several torpedo boats and destroyers suffered mishaps, mostly of a minor character and contrasting strongly in this particular with that of the *Bullfinch*, on the morning of July 21, which resulted in the loss of 11 lives. The boat was running the last of her steam trials—a full-power consumption test—the engines were making about 390 revolutions a minute and indicating 6,120 horsepower, when the connecting rod of the high-pressure starboard engine broke. The flying end of the rod smashed some of the mechanism and punched a hole in the bottom of the boat, and the breaking of the cylinder head allowed steam to escape in such quantities as to scald the 11 men referred to. The jury at the subsequent inquest found no precise evidence of the cause of the actual fractures, and considered that the rods were not capable of withstanding the great strain of the high speed of 29 or 30 knots. The weakness, they considered, emanated both from slightly faulty design—excessive boring and insufficient metal at the jaw at the point of vertical fracture—and from the unsatisfactory evidence of the quality of the material used. The jury also expressed their opinion that a surgeon should be carried on these trial trips. It is obvious that the machinery of such boats as the *Bullfinch* is highly specialized, and that its success and permanence depend on minute matters of detail, a knowledge of which can be obtained only by a long course of experience at sea with machinery of the kind.

Reference has already been made to some minor casualties. The *Cheerful*, in steaming down the Medway to carry out trials in October, became enveloped in a dense fog, lost her course, and ran on a bank, causing her engines to stop dead. After some time the vessel was got off and taken back to Chatham. In March several boiler tubes exploded on the *Earnest* at Gibraltar, badly burning and scalding 3 men. It is believed that overheating was the main cause, but whether due to neglect or to the defective condition of the tubes can not be positively stated. September 26, while the destroyer *Haughty* was entering the Tweed dock at Berwick, she came into collision with the concrete entrance wall. Her stem was crushed in, and she sustained considerable damage both above and below the water line. The *Hunter*, in September, was in collision in the Channel. Her bow was stove in so that she had to be towed into Portsmouth stern first. Upon the return to Plymouth of the second division of the Devonport instructional flotilla of destroyers, on the 21st of the same month, it was reported that the *Lynx* struck the *Ferret* near the engine room while manœuvering off Falmouth. Both vessels were damaged, but it was necessary to dock the *Ferret* only, which had her stern badly smashed and her engine tubes bent and torn, and other parts damaged. While the *Janus* was leaving the Medway, March 29, to undergo a trial of her machinery in the North Sea, one of the slide-valve rods of her starboard engine broke. She returned to Chatham with only her port engine working.

The *Swordfish* damaged her propeller and the *Janus* lost one of her torpedoes during the cruise of the Medway instructional flotilla. A breakdown of the port engine of the *Vulture* on her twelve hours' trial at Portsmouth in August necessitated her return to harbor, and in getting alongside the jetty she struck the piles, damaging her bows. A strong current in Mirs Bay carried the *Whiting*, attached to the China station, ashore in the spring of 1899, but she was soon got off and steamed back to Hongkong. The officer in charge was not only exonerated from all blame, but was complimented on his behavior in getting the ship off.

Between Portsmouth and Portland, on August 4, in a dense fog, the steel dispatch vessel *Surprise*, steaming at about 9 knots, crashed into the steam collier *Netley Abbey*, which had stopped. The entire crew of the latter climbed aboard the warship, and the collier sank in less than half an hour. The bows of the *Surprise* were a complete wreck at the water line, immense holes showing on both sides, and the plating all round was considerably dented and rivets started. The fore compartments were completely flooded, so that it was feared that some damage had been done below the water line.

FRANCE.

A singular accident happened to the battleship *Admiral Baudin* while she was in the dockyard hands at Brest in the spring. A sailor opened one of the inlet valves by mistake, and the water entered with such rapidity that for several hours tugs with powerful steam pumps were engaged in pumping her out.

During the summer, while the Northern Squadron was visiting Cadiz, the battleship *Courbet* swung over her anchors, and the upper fluke of one of them tore a hole in her double bottom. The inner skin did not stand the pressure of the water, and the pierced compartment filled with water. A diver was sent down, but was brought up unconscious and died shortly afterwards. Two other divers sent down were brought up in a fainting condition, and the attempt to stop the leak was abandoned and the vessel sent at once to Brest with 65 tons of water in the compartment. Though not very successfully done, they were enabled after considerable pumping to free the compartment, and the vessel left with the squadron for the northern ports to be docked later. The flooded compartment contained 55 cases of powder, which were lost.

While on a voyage from Quiberon to Brest, in October, the cruisers *Dupuy de Lome* and *Fleurus* broke down, the first in her machinery department and the latter developed some defects to her boilers.

In leaving the port of Dunkerque in September, the cruiser *Bruix* came in contact with the quay in the wake of her starboard forward

14 centimeter turret, and, notwithstanding the protection afforded by her side armor of 75 millimeters (2.95 inches) thickness, the turret support was displaced sufficiently to put the turret out of action and necessitate sending the vessel to Cherbourg for repairs.

The *Suchet* was delayed in leaving port August 21 because of some damage to the driving shaft of the port engine. A slight leak was discovered on the *La Hire* earlier in the same month, due to a rupture of a joint on the cock of a water pipe.

In April, while entering the roads at Brest with the rest of the Northern Squadron, the torpedo gunboat *Aquilon* struck on an unknown rock and broke off one of her propellers. Only a few weeks before a battleship of the same squadron was similarly injured through running on a rock not marked on the chart.

The list of casualties in the French navy in the course of the year, so far as they can be ascertained, is closed with the running aground of the training brig *Sylphe* at Brest, also in April. She was got off by a Government tug comparatively uninjured.

GERMANY.

At Cape Skagen, in July, the battleship *Baden* had one of her screws disabled while reversing the engines and laying out the anchor, caused by the anchor striking the screw. She proceeded to Kiel, and in dry dock there the damage was repaired in the course of a day.

In a snowstorm at Strand Bay, Holstein, in March, the battleship *Oldenburg* grounded on a sand-bank, but escaped without injury, being towed off by the *Brandenburg*.

In August the coast-defense vessel *Odin* and some torpedo boats were obliged to leave the manœuvring squadron, having more or less serious accidents. The *Odin* suffered serious injuries to her boilers.

An English steamer, the *Albato*, passed the manœuvring fleet and collided with the coast-defense vessel *Ægir* during the torpedo-boat attack. She struck the *Ægir* on the starboard side amidships with such force that a large leak was sprung, and a rapid-fire gun was thrown from its position to the deck. The leak was somewhat above the water line, 2.5 meters wide and 6 meters long. An indentation on the starboard side of the ram was made, beginning immediately above the water line, but there was no leak at this place, the armor of special Krupp steel withstanding the shock. The leak amidships was temporarily stopped, and the water tanks on the port side were filled to prevent the invasion of water. The ship then steamed to Kiel with a decided list to port and was docked.

In reversing her engines the protected cruiser *Hela* also sustained injuries to her screw shaft and propeller by colliding with a pier at

Neufahrwasser, and was obliged to leave the manœuvring fleet and steam back to Kiel with one engine useless.

The protected cruiser *Cormoran* stranded on a reef in the Bismarck Archipelego, near Australia, in the early spring, and laid there five days and six nights before help could be obtained to rescue her. The damages were not great, the keel being torn off as well as a considerable part of the wooden planking, but the steel plates were intact. The English navigation map, after which the ship was steering her course at the time, was found to be somewhat inexact, and there was an unusually strong current. The ship, after being worked off the reef, steamed to Sydney for repairs.

An explosion of the locomotive boiler on board the small cruiser *Wacht*, during the fleet manœuvres September 12, resulted in four firemen being instantly scalded to death and a number wounded. An investigation showed that the explosion was due to carelessness on the part of the boiler personnel. Thirty-six stay bolts which united the fire box of the forward port boiler with the side walls were torn out, whereby the hot steam (at a temperature of 200°) rushed into the fire room through an opening 2 meters long. It then passed through the smokestack into the open air, carrying the whole mass of burning fuel with it, which fell on the wooden deck and burned holes therein.

During the manœuvres the artillery school ship had her rudder yoke broken and had to put into Kiel for repairs; the torpedo boat *S. 85* sustained damage to her rudder; and the torpedo boat *S. 86* was badly injured in the bows in consequence of a collision.

It is reported that several defects have developed in the boilers and machinery of the battleship *Kaiser Friedrich III* and that in consequence the availability of the ship has been several months delayed.

AUSTRIA.

A disastrous accident occurred on Saturday, July 22, on board the torpedo boat *Adler*, which was cruising off Torcola Island, on the Dalmatian coast, training carrier pigeons, through the bursting of her boiler, by which one officer, three engineers, and a stoker lost their lives and two others were injured. The *Adler* is a vessel of 95 tons and 22 knots speed, built at Poplar in 1886, and it is believed that the explosion was due to an undiscovered flaw in the boiler. Prior to the cruise the vessel had been subjected to a careful official inspection, while the work on which she was engaged did not necessitate a high rate of speed. The machinery is said to be uninjured, and she will be quite fit for service when fitted with a new boiler.

Another torpedo boat, the *Bussard*, was also unlucky, as she came into collision with the *Monarch* during some manœuvres and had to be towed back to Pola.

TURKEY.

A telegram received in Paris from the Dardanelles in September stated that the Turkish cruiser *Ismir*, which was escorting the yacht conveying the Prince of Montenegro and his bride to Constantinople, was wrecked in Besika Bay.

IV.

NOTES ON ORDNANCE AND ARMOR.

By Lieutenant-Commander WILLIAM H. DRIGGS, United States Navy,
Staff Inteligence Officer.[1]

The war with Spain through which the country has just passed was supposed to settle many points that were open to discussion until tested by actual combat. It is a matter of regret that some of these questions in naval ordnance and armor protection are still unsettled, but in general the lessons of the war have been of much value to us.

In dealing with questions of this character there will always be those who, from one cause or another, hold opposite views, no matter what conclusions may be drawn. This is to be looked for as natural. Before the actual beginning, and, in fact, during the early part of the struggle, Spain's naval strength in some particulars was rated by some persons abroad and at home as fully equal to ours. We all remember the anxiety that was felt throughout the country when the news reached us of the departure of her torpedo fleet for this side of the Atlantic and how closely its movements were watched and reported. Some went so far as to urge the sending of a fleet to meet and destroy this flotilla even before war was declared. We also recall how much our deficiency in torpedo boats was deplored, and some harsh criticisms were heard of the failure to provide this country with a strong torpedo fleet.

Later in the war, when the delicate construction of these boats began to show as a serious weakness, and still later, when one was disabled by an auxiliary cruiser and two totally destroyed off Santiago, and it became known that of the fleet of five that started from Spain all had been disabled or destroyed from one cause or another, then the advocates of torpedo boats came to the front with the statement that the universal failure of these boats to inflict any injury to our ships was due to lack of dash on the part of their commanders. This excuse is untenable, as our experience during the war plainly shows that the

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[1] Before the completion of this article Lieutenant-Commander Driggs was placed upon the voluntary retired list with the rank of commander.

Spanish officers were far from lacking in this respect. The failure of these boats to inflict any damage to our ships was due to their inability to successfully run through our gun fire. This was plainly shown to be the case on several occasions, though never subjected to the broadside fire of even the secondary battery of a battleship.

These boats are good, no doubt, in other fields of action, but as used during the Spanish war they were an utter failure, and they would have been so in the hands of any other nation under like conditions: that is, if the attack had been made on a clear day. Five light rapid-fire guns can be depended upon to disable any torpedo boat before she can approach within the range of her torpedo, say 500 yards. On this basis a battleship could easily take care of two boats on each beam. What may be done under cover of fog remains to be seen, but even under conditions of this kind it must be acknowledged that it is quite as difficult for the torpedo boat to find the object of attack as it is for the battleship to see the torpedo boat, and any captain who so far neglects his duties as not to move his ship when a torpedo boat attack is probable simply courts disaster. The most that can be said for torpedo boats is that they exert a disquieting effect that necessitates constant watchfulness and consequent fatigue, while the results are in no way proportional to the reliance that has been placed in them.

This much we learned during the war. We learned also the great value of the rapid-fire guns, and, above all, we learned the paramount importance of accurate gun fire.

We knew our part better than we supposed we did, and when matched in battle were surprised at our own achievements. It is of little importance whether we made 3 per cent of hits, or what the percentage was. It was enough to show that in the face of a well-directed fire exposed or even lightly protected guns can not be worked, even when the battery strength is fairly well matched. The best pointing will soon so cover the enemy with bursting shell as to drive him from his guns.

To illustrate, we quote from the report of Admiral Montojo regarding the fire of the American ships in the battle in Manila Bay, as follows:

> The Americans fired most rapidly. There came upon us numberless projectiles.
>
> * * * * * * *
>
> A short time after the action commenced one shell exploded in the forecastle and put out of action all those who served the four rapid-fire cannon, making splinters of the forward mast, which wounded the helmsman on the bridge, when Lieut. José Nunez took the wheel with coolness worthy of the greatest commendation, steering until the end of the fight. In the meanwhile, another shell exploded in the orlop, setting fire to the crew's bags, which they were fortunately able to control.
>
> The enemy shortened the distance between us, and rectifying his aim covered us with a rain of rapid-fire projectiles. At 7.30 one shell destroyed completely the steering gear. * * * In the meanwhile another shell exploded on the poop and put out of action nine men. Another destroyed the mizzenmast head, bringing

down the flag and my ensign, which were replaced immediately. A fresh shell exploded in the officers' cabin, covering the hospital with blood, destroying the wounded who were being treated there. Another exploded in the ammunition room astern, filling the quarters with smoke and preventing the working of the hand-steering gear. It was impossible to control the fire. I had to flood the magazine when the cartridges were beginning to explode.

Amidships several shells of smaller caliber went through the smokestack, and one of the large ones penetrated the fire room, putting out of action one master gunner and twelve men serving the guns. Another rendered useless the starboard bow gun. While the fire astern increased, fire was started forward by another shell, which went through the hull and exploded on deck.

The broadside guns, being uninjured, continued firing until there were only one gunner and one seaman remaining unhurt for firing them, as the guns' crews had been frequently called upon to substitute those charged with steering, all of whom were out of action.

The ship being beyond control, the hull, smoke pipe, and mast riddled with shot, enveloped in flames, half of her crew out of action, among them seven officers, I gave the order to sink and abandon the ship before the magazines should explode.

* * *

This sad and graphic recital of the events that took place on the flagship of the Spanish fleet, the *Cristina*, can not fail to produce a feeling of pity for those who, though enemies, were bravely defending their ships under a deadly fire; nor can anyone fail to realize what the well-directed fire of a ship like the *Olympia* means. There may be those who read this paper that will advance the argument that the Spanish ships were overmatched in battery power. I can not agree that this was the case. It may be true of the ships alone, but they were supported by the shore batteries, and together their battery power was practically equal to that of the American ships. Even were we to admit that the Spanish ships were overmatched, still that would not account for the overwhelming difference in the results obtained by the two squadrons. In loss of men this difference was 381 to 0, and in ships (not counting launches) 13 to 0. Certainly no one will claim that our battery power exceeded that of the Spanish in the ratios shown here. The Spaniards are known to have had more men engaged than we had. Their entire squadron was destroyed, while the report of Admiral Dewey was that his squadron was in as good fighting condition after as before the battle, and that the casualties were seven men slightly wounded.

These wonderful results were obtained entirely by our superior skill in pointing and firing our guns rapidly. The destruction of the Spanish fleet off Santiago again demonstrated what can be accomplished by rapid firing and accurate pointing.

It is not intended to claim in these notes that our proficiency at target practice has reached perfection, far from it, but simply to show that our remarkable results were mainly obtained through our skill in handling our guns and to point out that this was the most important lesson learned during our war with Spain.

So many writers on the continent of Europe have endeavored to find excuses for the utter destruction of Spain's fleet (at Manila and Santiago) in the fact that the Spanish gunners were not trained in gun pointing that it seems as though some refutation should be made. If anyone will take the trouble to examine the logs of the fleet under Admiral Cervera, they will find, as I have, that the crews were drilled daily in this particular. Does it not strike the general reader as strange that it is only after the battles that this deficiency is known, while before the battles it was supposed that the American fleet lacked almost everything that they should have, while Spain, in constant touch with the superior training of the large nations of Europe, was expected to easily defeat the poorly organized force of the Americans? Their utter defeat on the sea, therefore, in a measure reflects on continental methods, and continental writers must find reasons and excuses which generally take the form of belittling our work and claiming want of skill on the part of the Spanish navy. If they had brought these arguments forward before the war they would have had more weight. The percentage of hits in the battle off Santiago was said to be between 3 per cent and 4 per cent. This seems small, and is small in comparison with the routine prize firing; but it was enough to demolish a modern fleet in a very few hours, and before any damage could be inflicted in return. What more is needed? Besides, I do not agree with this percentage. All the ships but one were destroyed by gun fire, sunk, and burned, and from that part remaining after the fire and above water a fictitious percentage of hits has been made up, unfair from any point of view.

For many years the rapid-fire gun has been growing in importance, and European nations are making important changes in their armaments to extend its use. Target practice also has acquired new life, and the principal naval powers are largely increasing their allowance of ammunition for it.

England, France, and Germany have each a most elaborate system for instructing marksmen, and each makes this practice as near that of actual combat as possible.

An exceedingly instructive practice was carried on during the last winter by the English navy, which demonstrated practically what can be done by a well-drilled ship in defending itself against attacks of torpedo boats.

In this trial torpedo boat *No. 28*, which has been badly damaged by taking the ground, was used as a target. The boat was made watertight and set adrift in False Bay to be attacked by the squadron under admiral Sir Robert Harris. The squadron consisted for this practice of the *Doris*, *Monarch*, *Magicienne*, and *Tartar*. The squadron was formed in column and steamed in that formation so as to pass the target. The guns used were the 12 and 13 pounder R. F. The first three shells fired struck the conning tower and boiler rooms, and would have completely disabled if not sunk her had she been a torpedo boat in commission for active service. As it was she began to settle and the *Tartar*, watching for a favorable time, put a shell through her bottom as she rolled away from her, which soon sent her to the bottom.

The practice in all lasted about five minutes, but the boat was in a sinking condition after the first three rounds. It was anticipated that the whole squadron would have a chance to exercise their guns' crews in this practice, but as a matter of fact only the flagship had the opportunity, as the target was destroyed so early in the firing.

The French Government have for some years recognized the many benefits to be derived by using condemned ships as targets and closely observing the effects of shell fire upon them. This year the Mediterranean Squadron has passed through a most interesting and instructive practice. The vessel used in this case was the *Admiral Parsival*, a condemned cruiser of 870 tons built of wood. In order that she might be kept afloat as long as possible she was filled below with empty barrels and many weighty objects, smokestack, bridges, etc., were removed from the spar deck.

A commission was appointed to examine and report as to the effects of the attack, and the cruiser *Cassard* was detailed to take the board and conduct the firing. After each shot the hulk was examined. The reports that have reached us thus far are meager and indicate that the trials are not as yet complete. So far thirteen service shell of 14 centimeter (5.5 inch) caliber have been fired into the hulk, five into one beam and six into the other, while two were fired into the stern. The most remarkable, and thus far unexplained, feature of this practice is that out of the thirteen shell bursting in the hulk not one set her on fire. The engines, however, suffered great damage.

The objects of this practice were to establish:

First, the possible percentage of hits that might be made at different distances with the firing vessel under way at high speed, and on a course requiring constant change of distance and train.

Second, the percentage of shots that may reasonably be looked for to take effect along the water line.

Third, the study of improvements in the control of gun fire from a moving vessel.

Fourth, the study of the effects of the explosion of shell of different calibers, and charged with different explosives.

The French Government is seriously considering a proposition to fit one of the small coast defense battleships for a target to carry on these important researches. The expense, no doubt, of conducting such experiments is very great, but the lessons learned are conclusive and far better from every point of view than theories and long drawn-out discussions, which in general convince no one.

The points on which information is sought are the most important in naval science, and if they can be conclusively determined the matter of expense is of but little consequence.

In the matter of target practice we also have an account of some late practice conducted by the French Mediterranean Squadron, which comes from reliable sources, though not official.

This practice was held in September last, the target being stationary and on shore, while the firing ships were under way. The ranges varied from 3,000 to 4,200 meters, both main and secondary batteries taking part. The information is not sufficiently detailed to determine the percentages or number of fires from each class of gun. The vessels taking part included: 9 battleships, 4 coast-guard battleships, 4 armored cruisers, 4 second-class cruisers, 4 third-class cruisers. The best percentage was made by one of the second-class cruisers, carrying in her main battery six 6.4 inch R. F., four 3.9 inch R. F., and secondary battery of thirteen light guns. This vessel fired 51 rounds in nine minutes and made 72 per cent of hits. Three of the vessels made as high as 61 per cent of hits; two were as low as 22 per cent; two made but 28 per cent; seventeen made over 40 per cent.

The rapidity of fire was not as high as might be expected. The battleships had a rate of about two to four shots per minute, including both main and secondary batteries. That is, one fired 65 rounds in thirty-one minutes, another 87 rounds in eighteen minutes, still others 99 rounds in thirty-five minutes, 51 rounds in twenty-seven minutes, and so on.

Two of the third-class cruisers did better, one firing 36 rounds in three minutes and the other firing 82 rounds in eight minutes. In other words, while the percentages of hits were good, the rapidity of fire was poor, and this notwithstanding the fact that the ships firing were armed with modern rapid-fire guns.

In explanation, it should be mentioned that the speed of the ships in passing the target was between 10 and 12 knots, and the range from 3,000 to 4,200 meters. The target was a rocky point about 11 meters high by 23 meters long. Only actual hits counted.

There is one feature worthy of note in the French practice against the hulk *Admiral Parcival*, and that is that during all the firing done against this ship, and a wooden one at that, she was not set on fire once with the 14 centimeter (5.5 inch) projectiles, though the shells were filled with black powder. During the firing last year a blaze was started by one shell, but was so slight that it went out of its own accord.

Without knowing the interior arrangement of the *Parcival* it is impossible to account for the failure of the shell to ignite her, but if bulkheads and fittings have been removed it is quite possible that the shell did not explode in a space sufficiently confined to ignite the wood.

PLATE B.

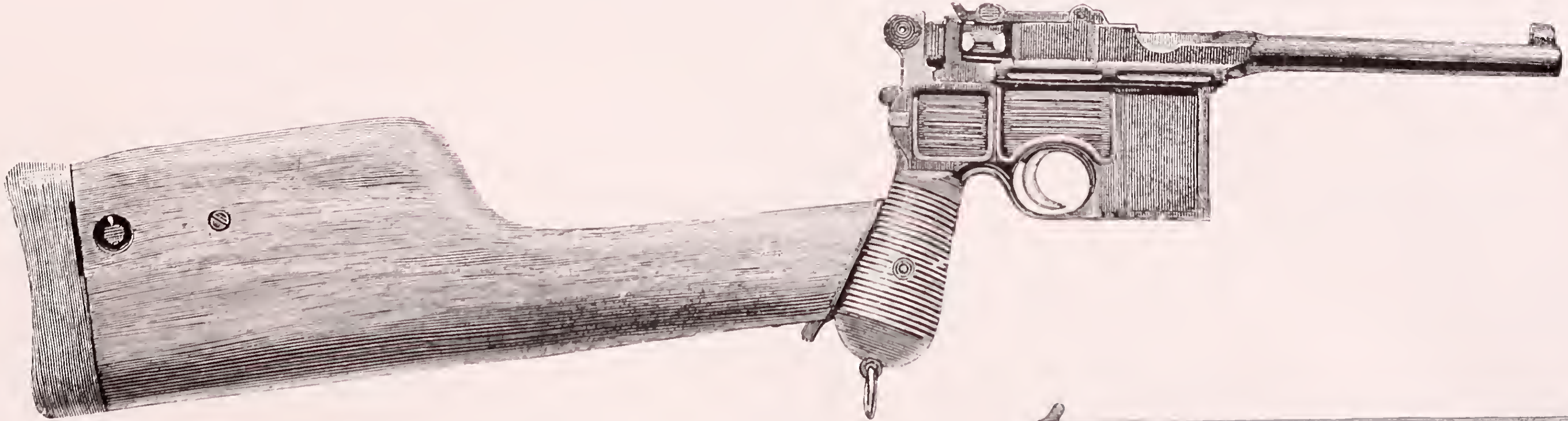


Fig. IV.

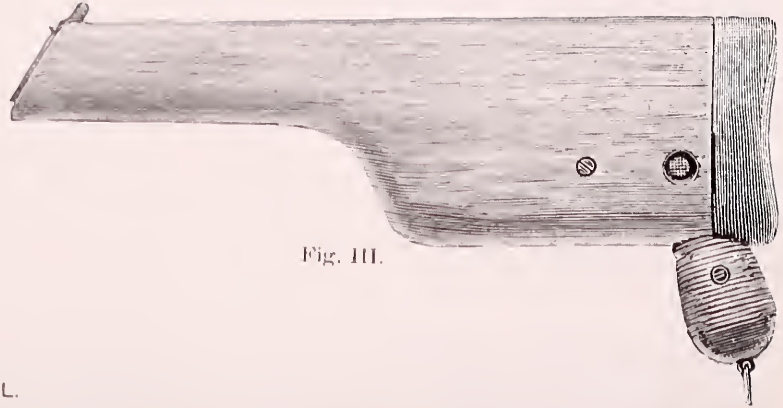


Fig. III.

MAUSER AUTOMATIC PISTOL.

PLATE A.

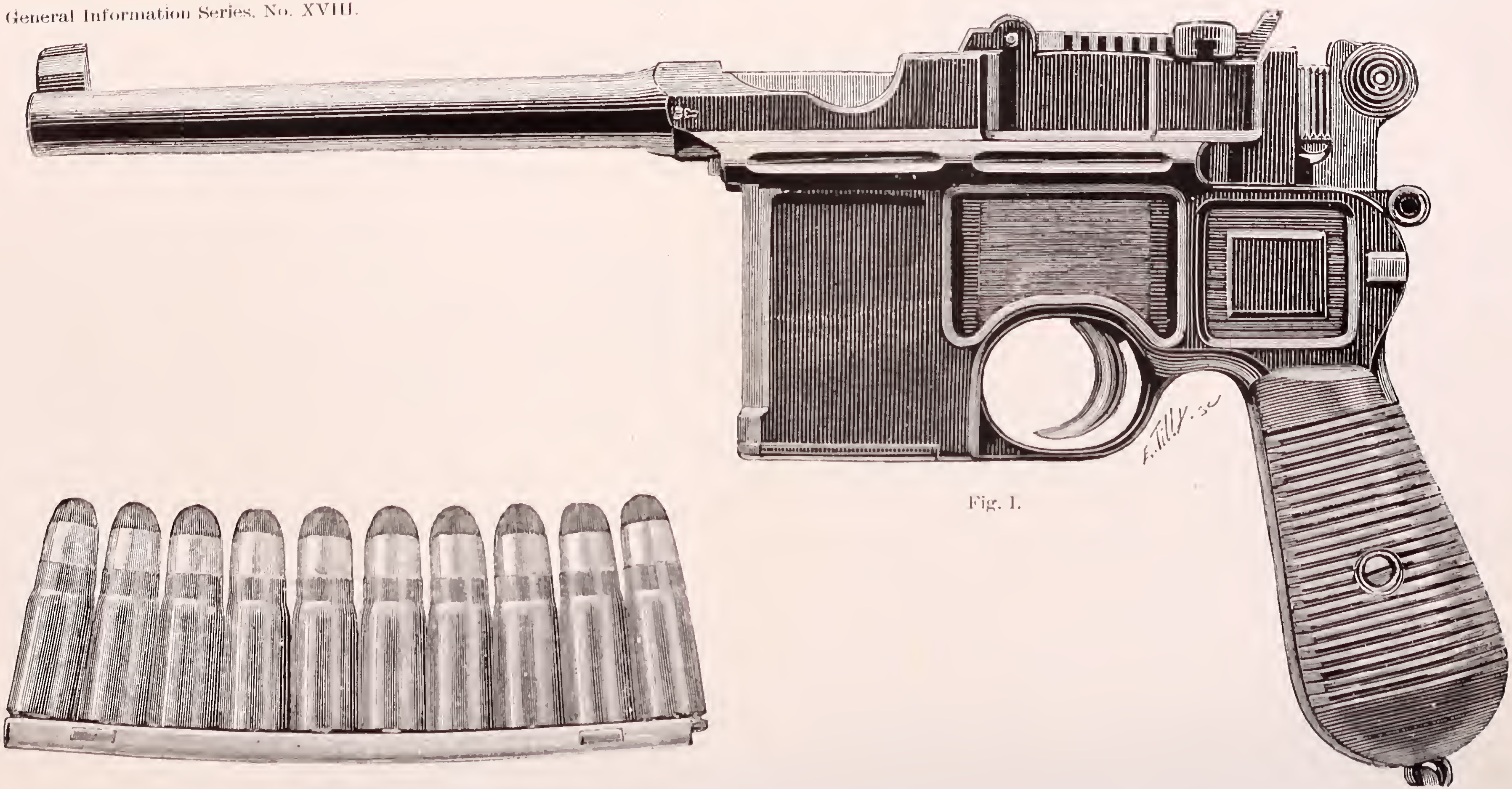


Fig. I.

Fig. II.

MAUSER AUTOMATIC PISTOL

A shell exploding on an open deck could not be expected to produce fire, but exploded in the cabins, storerooms, or like confined places will almost always start a fire.

AUTOMATIC FIREARMS.

Within the past year automatic firearms have been much more favorably considered than formerly, and while some have failed to meet the claims of their inventors or failed to fill the place assigned them satisfactorily, still the advantages to be derived from an automatic arm are so great that the foremost nations in naval and military strength are gradually moving toward the adoption of arms of this type. Leading in this movement we find both Germany and Italy adopting the automatic pistol for their officers in the army and navy. The advantage of this system for cavalry is easily seen, as a pistol for this service should be so constructed as to be operated with one hand, leaving the other free to guide the horse. The self-cocking or double-action revolver also had this advantage, but the effort to cock the piece deranged the aim, the reloading consumed time, and the piece fired but six rounds, while the automatic fires ten. Besides, these 10 are contained in a clip loaded in one motion into the pistol and the empty cases are ejected automatically after each discharge. Simply holding the trigger back discharges in succession the whole ten charges.

The pistols are made by Mauser, at Oberndorf, Germany.

Plates A and B represent the pistol complete. The magazine is represented at the central part, forward of the trigger. It holds ten rounds, which are fed into it from a clip, and when so loaded they slightly overlap each other, thereby saving space. Fig. 2 represents the clip, similar to that used with the Mauser rifle. Fig. 3 shows the pistol in its case. Fig. 4 shows the manner of mounting it on its case as a carbine.

The details of the pistol are as follows:

Total length	inches	11.42
Number of grooves of rifling		4
Caliber	inch	.3004
Pitch of rifling, one turn in	inches	9.84
Length of cartridge	do	1.378
Length of projectile	inch	.54
Weight of pistol	pounds	2.59
Weight of cartridge	grams	10.7
Weight of projectile	do	5.5
Weight of powder	gram	.5
Weight of case	grams	440
Initial velocity (muzzle)	foot-seconds	1,394
Penetration at 32 feet	pine, inches	10.6
Penetration at 50 feet	do	4.7
Penetration at 984 feet		Breaking bone and penetrating human arm
Extreme range	feet	3,280

This pistol belongs to that class of automatic firearms actuated by the recoil of the barrel, which in turn operates the mechanism. The barrel has only a slight movement, but sufficient to operate the breech-block, unlock it, carry it to the rear, extract the empty case, and compress the counter-recoil spring, which in turn returns the block to the chamber, pushing in front of it the new charge, locks the block, and fires.

Many other forms of automatic guns or pistols have of late been placed before the public, and some have had official tests. First of these may be mentioned the Bochardt, which was officially tested, and a report generally favorable was made, but none have been placed in service.

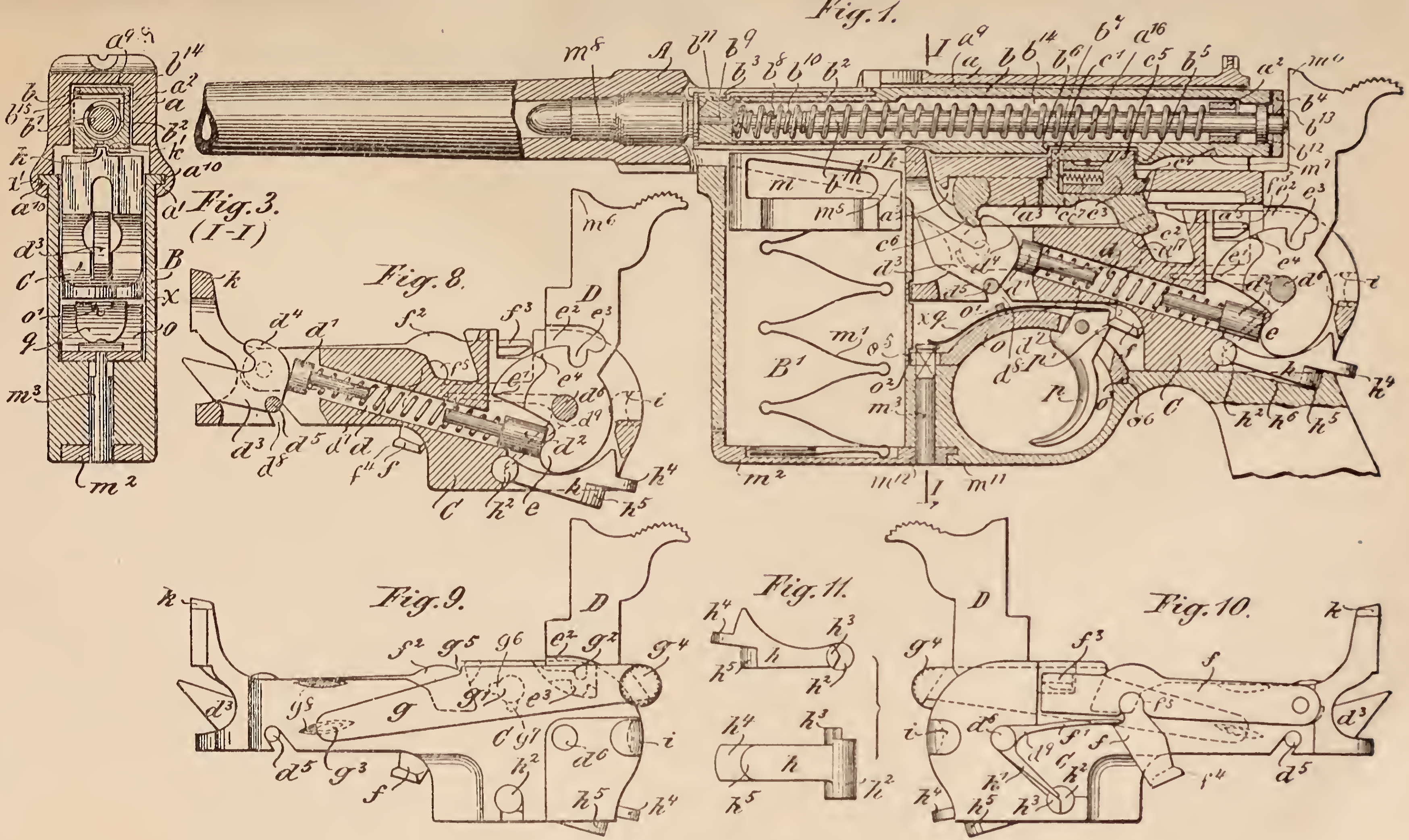
This arm operates by the recoil of the barrel, and in that respect is similar to the Mauser.

The great importance of this subject, owing to the adoption of this pistol by two first-rate powers, leads us to offer here a detailed description, as follows:

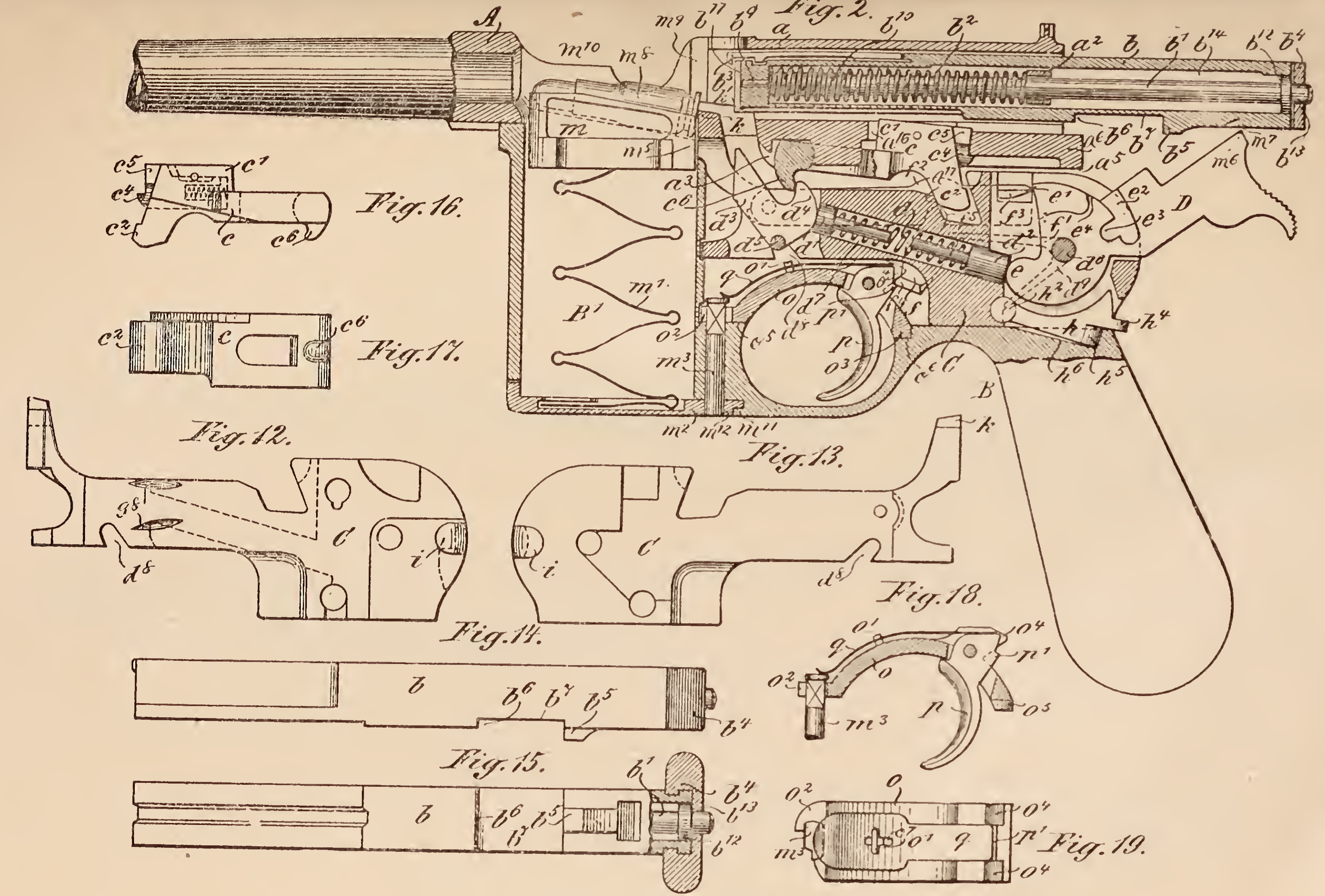
In the drawings, Fig. 1 is a fragmentary vertical longitudinal section through a locked and bolt-locked firearm, the parts being in the position occupied at the moment of firing. Fig. 2 is a similar view, but showing the breech opened and the hammer cocked. Fig. 3 is a cross-section drawn on the line I–I of Fig. 1 and looking rearwardly. Fig. 4 is a side view of the barrel withdrawn from the lock-case and showing a longitudinal vertical section of the receiver and the locked breech-bolt. Fig. 5 is an under side view of the barrel. Fig. 6 is a fragmentary longitudinal vertical section through the lock-case and the cartridge magazine. Fig. 7 is a plan of the same. Fig. 8 is a longitudinal vertical section through the lock. Figs. 9 and 10 are opposite side views of the same; and Figs. 11 to 19, inclusive, are views showing details.

The essential parts of the arm are the following: First, the barrel A, the rear end of which serves as a receiver *a* to the breech-bolt and the bolt-locking block; second, the lock-case B, which serves at the same time as a cartridge-magazine B′, and is provided at its upper edges with ribs a^{10} to guide the movable barrel; third, the part C, which contains the firing and securing mechanism and is coupled to the barrel through means of the locking-block *c*, so as to bring the latter under the influence of the mainspring and thereby cause by the rearward movement of the barrel the unlocking of the breech-bolt.

As previously stated, the function of the firearm is based upon the known principle of using the recoil to move the barrel. The mechanical action performed by the rearward-moving barrel is only a preliminary one and serves to unlock the breech-bolt and to cock the gun, but at the same time by the great velocity of the rearward movement of the barrel, and in spite of the relatively small distance traveled by the same, such a momentum is given to the breech-bolt as to enable the latter to over-



MAUSER AUTOMATIC PISTOL.



MAUSER AUTOMATIC PISTOL.

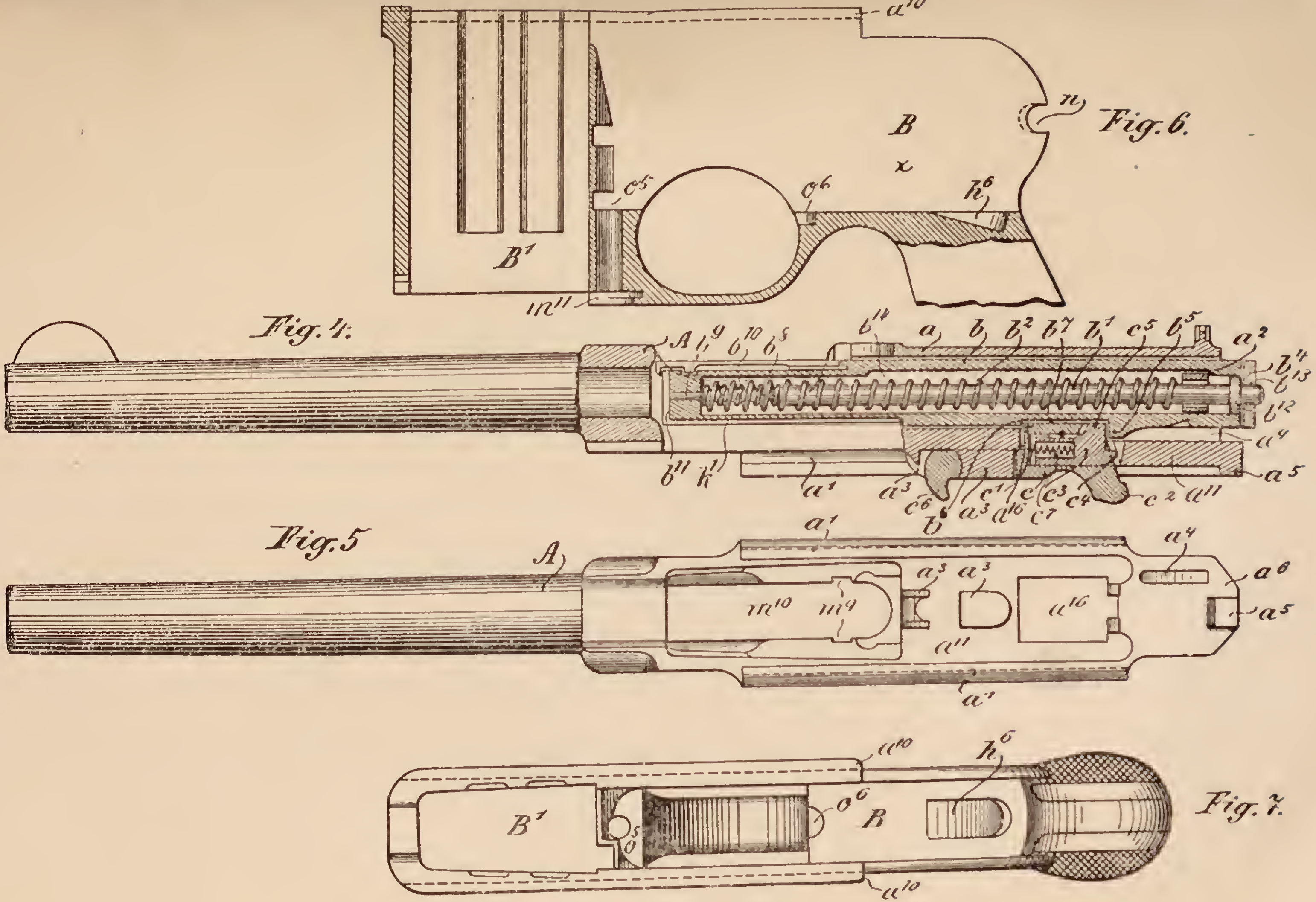


Fig. 6.

Fig. 4.

Fig. 5

Fig. 7.

MAUSER AUTOMATIC PISTOL.

come the resistance of its restoring-spring and to fully open the breech and eject the empty cartridge-case. The loading of a fresh cartridge, the locking and bolt-locking of the breech, the forward movement of the barrel, and finally the firing are effected, as above stated, partly by the restoring-spring and partly by the mainspring, which springs were both compressed by the recoiling parts of the firearm at the moment of firing.

The barrel A is formed with or has at its rear part (see Figs. 4 and 5) the receiver a, in which a sliding bolt b of suitable cross-section is placed. The receiver is provided with means to receive the locking-block c, serving to lock the breech-bolt, and with guides or grooves a' for the coupling of the barrel to the lock-case B and to enable the barrel to slide thereon.

The bolt b is shown in square cross-section and has a central bore (see Figs. 1, 2, 3, and 4) to receive the firing-pin b' and the restoring-spring b^2. The forward part of the bolt is provided with a cartridge-shell extractor b^3 at the rear underpart, with a notch or recess b^7 for the locking-block c, and flanked in front by a nose b^6 and in rear by a nose b^5, serving to receive the locking-block c to lock the breech-bolt.

As shown at Figs. 1, 2, 3, and 4, a hollow projection or pin a^2, fixed to the receiver, projects into the hollow interior b^{14} of the breech-bolt through an opening b^{15} in the side thereof and serves as an abutment for one end of the restoring-spring b^2, the other end of which presses against the front end of the interior of the breech-bolt, thus holding the latter in a closed position by its pressure. The firing-pin b' has at its front end two reductions in diameter b^8 and b^9, and has a small spiral spring b^{10}, surrounding its portion b^8, by which it is held back behind the closing face or plate b^{11} of the breech-bolt b, so that it shall not touch the cap of the cartridge except when it is pushed forward by means of the hammer D. The rear end of the firing-pin is provided with a collar b^{12}, which abuts against a cap or closing-bar b^4, having a milled handle carried on, coupled to, or slid over the rear end of the breech-bolt, thus closing the latter at its rear end. This cap or closing-bar is held in its position by the rear end of the firing-pin projecting into or through its recess b^{13} and out of the breech-bolt, when its end can be struck by the hammer D.

The locking-block c, which serves to lock the breech-bolt closed, is movably and removably connected to the under side of the receiver a, so as to turn freely round one of its ends, by means of a small flattened cross-bar slid between or engaged by claw-shaped projections a^3 a^3 on the case a. The other end of the bolt-locking block c forms or has at its upper side a locking nipple c', which projects through a suitable hole a^{16} in the bottom of the breech-case a and enters the recess b^6 in the breech-bolt b, and thereby secures the latter closed, while the lower rear end of the locking block c is provided with a tailpiece c^2, which at the forward movement of the barrel comes into contact with an inclined surface a^{17} of the part c, which causes it to move upward, and thus causes the nipple c' to enter the recess b^6 before the barrel A can be pushed forward into the firing position. Upon this condition the proper functions of the arm depend, as it is impossible, on the one hand, to fire the arm unless the barrel has been fully returned to its initial or firing position, and as, on the other hand, if the barrel had stopped behind after the firing it could not make the before-mentioned backward movement, which is necessary to put the arm in a condition ready for firing.

As the closing of the breech and the forward movement of the barrel are caused, respectively, by the action of two separately-operating springs—viz, the restoring-spring b^2 and the mainspring d—it will be necessary to make the functions of the latter spring depend on the former spring in such manner that the breech must be closed before the barrel can be pushed forward. For this purpose a catch c^3 is provided at, in, or on the rear end of the locking-block c, between the locking-nipple c' and the tailpiece c^2, which catch, projecting rearward, is constantly under the pressure of a small spiral spring c^7 and kept with its nose c^4 against the under side of the receiver a, thus preventing the upward movement of the locking-block until the breech-bolt b, at its advancing movement, caused by the restoring-spring b^2, abuts its cocking-nose b^5 against the projection c^5 of the catch c^3, whereby the latter is pressed back into the locking-block c, so as to release the nose c^4 from the receiver, whereupon the upward movement of the locking-block, as well as the advancing movement of the barrel, can be effected in proper order.

Having thus far explained the peculiar features of the firearm with respect to the functions of the movable barrel and to the opening and closing and locking of the breech-bolt, I will now describe the manner in which the mainspring d causes the advancing movement of the barrel, as well as the special arrangements of the lock in connection both with the whole mechanism and with the mode of fixing the same within the lock-case.

As shown by Figs. 8, 9, and 10, the lock of the firearm consists of a main body C, carrying, with the exception of the trigger, all the parts necessary for firing, for coupling the lock to the barrel—that is to say, the locking-block c—and for fixing the lock within the lock-case B. The lock-body C is provided with a longitudinal oblique bore or socket d^7, within which the spiral mainspring d, acting on two press-bolts d' and d^2, is placed. The mainspring presses at one end against the tail portion e of the hammer D and at its other end against a hook d^4 of the coupling device d^3, carried by bearing-pins d^5, pivoted in suitable cuts or recesses d^8 in the side walls of the lock C. The coupling device d^3 serves, through the power of the mainspring d, to cause the advancing movement of the barrel and the uncoupling of the locking-block c by pressing its hook d^4 against a claw c^6 of the locking-block c, thus causing the latter either to turn downward, whereby the breech-bolt b is unlocked, or, when this can not be done by reason of the relative positions of the respective parts, causing an advancing movement of the barrel to take place. It will be clearly understood that in consequence of the leverage of the mechanisms the force applied to cause the advancing movement of the barrel is by far greater than that causing the unlocking of the locking-block.

In the rear portion of the lock C is pivoted the hammer D, the axis d^6 which has at one end a forked leaf or double spring d^9 (see Fig. 10), the one arm, f', of which acts upon the trigger mechanism f, the other, h', serving to keep down the lock-holding device h. Besides being in operative connection with the main spring d the hammer D is also directly in operative connection with the trigger-bar f and the safety device g. The trigger-bar f, under the influence of the above-mentioned arm f' of the double spring, acts on a lever f^2, so as to cause the sear-nose f^3 of the latter to set against the beak e' of the hammer, thus holding the latter cocked.

The safety device g is pivoted by means of a bayonet-joint, preferably consisting of a pin g', having a key-shaped head g^6, which enters a similarly-shaped eye or socket g^7, provided in the left side of the lock C, and this device is held in both its extreme positions by means of a catch or nipple g^3, which enters suitable recesses g^8 in the side of the lock. When in the inactive position, the safety-nose g^2 of the device rests and moves in a groove or recess e^2 in the hammer D, and when in the active position this nose enters the notches e^4 or e^3, according as the hammer is to be secured in a cocked or uncocked position. When the safety device is active, its nose g^5 (see Fig. 9,) enters a notch a^4 in the under side of the receiver, (see Fig. 5,) and thus prevents the opening of the breech by fixing of the barrel against rearward movement.

The setting of the safety device is effected by means of its handle or knob g^4, projecting at the rear end of the lock.

There still remains to describe the last part of the lock—viz, the lock-holder h, which is pivoted by means of a pin h^2 at the under side of the lock-body and is actuated by the arm h' of the double spring d^9 and serves to hold or couple the lock C, and with it the barrel, within or to the lock-case B, when the arm is completely mounted, as will be clearly understood from an inspection of the drawings. For this purpose the spring h' acts upon the inclined part h^3 of the pivot-pin h^2, so as to force down the rear end of the lock holder h, whereby the latter, when the lock is in position in the lock-case, abuts with its nose h^5 in the recess h^6 of the rear wall of the lock-case and prevents the lock and the barrel from accidentally sliding out of the lock-case. The lock-holder h is normally held in its holding position by the tail portion e of the hammer D. (See Fig. 1.)

In order to dismount the firearm—that is to say, to take off the barrel and to remove the lock from the lock-case—the hammer requires to be full-cocked and the lock-holder turned up by means of its handle or lip h^4, projecting through the rear of the lock far enough to enable the nose h^5 to leave the recess h^6 at the rear part of the lock-case, after which the barrel and the lock can be pulled out of the lock-case. The front portion of the lock C extends far enough upward to serve as an ejector for the empty cartridge-cases, having a nose or piece k, which partly projects into the path or way of the breech-bolt, entering a groove k' therein and serves as an ejector, so that the empty cartridge case or shell on the opening of the breech strikes against the piece k and is thereby ejected.

The cartridges m^8 are stored on a plate m in the interior of the magazine, which plate, being raised by a spring m^1, brings the cartridges within the path or way of the breech-bolt b. The magazine-bottom is closed by a plate m^2, which is held in its position by means of a spring-actuated bolt m^3 and can not be removed till the bolt m^3 is pressed far enough up to permit the plate m^2 to be slid under it. The plate m is provided at its rear end with a rib m^5, which, when the magazine is emptied, comes against the front end b^{11} of the recoiled breech-bolt, thus preventing the advancing movement of the latter. By this means the user's attention is called to the fact that the magazine is empty and to the necessity of refilling it, which refilling is effected in any well-known manner, as by means of cartridge-holders. These holders containing a suitable number of cartridges may be introduced into corresponding grooves m^9 in the side walls of the opening m^{10} in the receiver at the front end of the same in such a manner that the cartridges from the holder are caused to drop into the magazine, after which the holder is withdrawn from the receiver, when the breech-bolt by being moved forward pushes a cartridge into the barrel, whereupon the firearm is again ready for firing.

If a partially-emptied magazine is to be filled up, this may be done either by withdrawing the breech bolt b by hand and supplying a cartridge-holder, as before stated, or, if it is desired to fill in only a few single cartridges, by withdrawing the breech-bolt and fixing the same by slightly uncocking the hammer, the point m^6 of which, abutting against a corresponding face m^7 of the breech-bolt, will hold the latter back until the hammer is recocked after the magazine is refilled. If after this the hammer is recocked, the breech-bolt is moved forward by its spring b^2 and pushes with it the uppermost cartridge into the barrel in the manner before described.

Figs. 1 to 7 of the drawings show the arrangements adopted for the lock-case for receiving and guiding the barrel and for receiving and holding the lock in position. The ribs a' at the upper edge of the lock-case serve to guide the barrel and the groove h^6, and cuts n at the rear end of the lock-case serve to hold or retain the whole of the upper mechanism within the same. The lock rests with its upper part against the barrel, or, rather, against the receiver, and with its lower part against the trigger-guard o, thus fixing the latter in position. The trigger-guard piece o is secured in its proper position within the lock-case by means of projections or pins o^2 o^3, entering suitable recesses o^5 o^6 in the lock-case, and consists of a strong curved plate carrying the trigger p and the trigger-spring q. The latter is double ended and is made to act on both the trigger and the bolt or pin m^3, which locks the magazine-bottom plate m^2 in position. The plate m^2 slides into a socket m^{11} in the case B and has a recess m^{12}, receiving the pin m^3. As shown at Figs. 18 and 19, the trigger-spring is fixed to the upper side of the trigger-guard piece by means of a hook o' by passing the latter through the hole o^7 in the spring and turning the spring through a distance of ninety degrees.

The functions of the trigger are well known, but the peculiar construction of the firearm requires that the trigger-bar f, and with it the lever f^2 and its nose f^3, shall ordinarily return immediately after firing to their initial positions and catch the newly-cocked hammer without waiting for the release of the trigger p. For this purpose the trigger is pivoted to the trigger-guard piece o, so that its nose p' shall act upon the nose f^4 of the trigger-bar f only to the extent required for the release of the hammer. Then by moving it farther it becomes disengaged from the trigger-bar f by pushing the nose f^4 of the latter upwardly against the projection o^4 on the piece o. The nose f^4 is forced back as the bar f swings on its movable coupling f^5 with the lever f^2 until the nose f^4 is moved off the trigger-nose p', whereupon the bar f and lever f^2 are free and the trigger-bar f is caused by the spring f' to return to its initial position and to catch and hold the newly-cocked hammer.

In order that at the releasing of the trigger the nose p' may be replaced beneath the nose f^4 of the trigger-bar in readiness for the next shot, said bar f is pivoted by the coupling f^5 to the lever f^2, so as to give way to or snap over the rearwardly-moving trigger-nose p' and enable the latter to pass under it, whereupon the influence of the spring f' returns it against the top of the nose p'.

In a few words certain advantages of the firearm may be stated to consist in, first, the small number of and compact arrangement of the parts composing the arm; second, the facility for dismounting and remounting the firearm without the aid of any tool; third, the absence of screws of any description.

AUTOMATIC MACHINE GUNS.

This term is used to distinguish automatic rifles mounted like field artillery, or on fixed stands on shipboard, from those used as shoulder rifles. And under this head is classed the Maxim, Colt, and Hotchkiss automatic guns.

The several failures of the Colt automatic gun during the Spanish war has led the War Department to institute a competitive trial of automatic machine guns for army service. Thus far four guns are entered for the trials. They are the Maxim, Colt, Hotchkiss, and Carr. This last-named gun is the invention of Howard Carr, a resident of California. The gun has had several trials, but never before brought in competition with others.

In some particulars the gun is similar to the Mauser automatic pistol: but, unlike most of the automatic guns, all the operations of opening, ejecting, loading, and firing are performed on the counter-recoil. During the recoil the breech-block is firmly locked to the barrel. It is well understood that the belt-feed in use with guns of this class is a serious objection, and has therefore not been adopted for use with the new Carr gun. In place of it a drum holding 345 rounds is used with a positive feed, both very simple and reliable. Another advantage claimed by the inventor is the extreme lightness of the gun, which, including the tripod-stand, weighs but 25 pounds—10 pounds being in the gun and 15 pounds in the stand. There is no water-jacket, but, owing to the light weight of the piece, two guns are mounted on one pair of wheels for land service. The official trials are still in progress, so that the result may not be known for some time.

The piece may be fired automatically by holding back the trigger or in single shots by pulling for each. Automatically fired, the rate is 300 rounds per minute. This is not as great as some of the heavier guns, but compared on weights exceeds any other. The extreme lightness of the gun and the compact stowing of the ammunition, together with the ease and rapidity with which the drums can be refilled, are the main advantages of the system.

The weight of machine guns has shown seriously against them in late campaigns, and it is mainly for this reason that the automatic guns are now coming to the front. The feed drum weighs, filled, 30 pounds, and this is the heaviest single piece in the outfit. If mounted as a landing gun the wheels would be slightly heavier, viz. 43 pounds, but even these could be carried by two men some distance without great fatigue. It is apparent, therefore, that this gun has many advantages over the old Gatling or over the heavier automatic guns.

NEW BREECH MECHANISMS.

During the year there has been unusual progress made in improving the rapidity of fire of guns of medium and heavy caliber, and especially of field guns.

The English Government has practically adopted the Vickers design, using the Welin screw-block, and the Ordnance Bureau of the United States Navy has obtained the rights to use these patents. A 6-inch gun of this make was purchased abroad, and when tested at the United States naval proving grounds gave excellent results. The main advantages claimed for the design are probably well known, but it may not be amiss to enumerate them here. They consist in

First. The additional support given the block by the peculiar construction of the thread. There are but two blank spaces, the exterior thread being stepped radially, each of the three steps being increased by the depth of the thread, so that a slight movement engages it on all but one-third of the circumference. The block in use in the United States previously lost one-half of the circumference in blank spaces. The Welin block, therefore, will have the same resisting power on less weight.

Second. The primer is automatically ejected on opening.

Third. On opening, a tray to protect the screw-box is automatically placed for loading, and removed automatically as the breech is closed.

Fourth. No metallic case is used, as it has been found unnecessary. With smokeless powder there is practically no residue left in the chamber, and with the long strips of this powder the cartridges hold their shape well. No sponging is required.

The rate of fire for the 6 inch gun is 8 rounds per minute. This, of course, with a well-drilled crew. The rate of fire for the 8 inch gun is said to be 5 rounds per minute under like circumstances.

While the English Government has adopted this type, it is not to be understood that it meets with universal favor. It is said that the Armstrong Company gave the system a long and complete test and finally rejected it, notwithstanding that Welin was at the time in their employ. It is also said that the Swedish Government in placing late orders specially noted that the Welin block was not to be fitted to their guns.

England, however, is now having built more than 200 of these guns of 6 inch caliber. They are all to be 45 calibers long, and the gun body will be wire wound, covered by a light jacket.

The same system is being used in the 12 inch guns building at Vickers's and Armstrong's factories. While the United States Navy have not adopted the wire-wound guns, it is practically assured that our 6 inch guns will in future use the Welin breech mechanism.

While the Welin block has an increased holding surface over that of the older styles of slotted screw, still designs have been perfected during the year going even beyond this by using a peculiar-shaped block with spiral thread which engages throughout its entire circumference. Several patents covering this idea have been developed of late, but the most noteworthy is that patented by Lieutenant Haeseler, U. S. N.

A trial mechanism of this design was fitted to a 4 inch gun which gave most excellent results, showing great ease in working and great rapidity of fire, even under the high pressure of 16 tons per square inch, which might be expected to make the starting of the plug in the opening of the piece a little hard.

The thread around the circumference of the block is V-shaped and cut on a spiral. Three threads being cut parallel to each other giving the plug the appearance of being stepped.

Though the plug is engaged around its entire circumference when locked, it is unlocked by only one-sixth of a turn. There are but the two motions in opening, one unlocking and the other swinging clear.

The increased holding surface over any other block yet used gives it a decided advantage in the larger caliber guns, as the same strength can be obtained on very much less weight, and in guns over 8 inch caliber this is an important object.

An 8 inch gun is now being fitted with this new design for trial.

It might be supposed that a spiral thread would produce such a steep pitch as to rotate and open the block under high pressure. It was found on trial that this was not the case, but as a precaution against such an accident a strong lock against turning has been fitted to the mechanism.

Two new designs of light R. F. guns have been placed in service in the United States Army during the year. Both are the output from the shops of the Driggs-Seabury Company.

One of these is a 6 pounder, similar in general appearance to the Driggs-Schroeder gun, but which has some notable improvements upon that design. Including the block, there are but five tactical pieces, viz: Block, extractor, cam, handle, and firing pin, spring, and trip combined in one.

There are no screws about the gun. The firing mechanism is on the principle of a self-cocking pistol; that is, when the lanyard is pulled the firing pin is cocked to the full extent and released, which fires the piece and leaves the mechanism in position for the next fire.

By the adoption of this system the gun is much simplified. There is no face-plate sear or sear spring, and the gun is never cocked for firing until the firing lanyard is pulled.

The firing pin, spring, and trip are all connected, so that they are entered and placed in the gun or withdrawn with one motion, so that they form tactically one piece.

The mounting for this gun is entirely novel in construction. The top carriage is identical with the 6-pounder recoil mountings for the Navy. In place of the stand, the pivot ships into a socket on the axle of a field carriage. There is a span from this axle which can be bolted to the parapet of a fort or any fixed position, and the mounting is high enough to permit the gun to look over any protection of standard height. Besides this, the trail is fitted with a heavy shoe, so that when used in the field there is practically no recoil to it. There is a small train of the piece independent of the wheels, so that after once roughly laid the gunner can stand on the steps, provided for that purpose on the trail, and fire the gun as rapidly as if mounted in a fixed position in a fort or on shipboard. The gun body is similar to all guns of this caliber now in service. With the smokeless powder now being used the muzzle velocity is 2,500 foot-seconds in the 50 caliber guns, this being the established length.

The other piece is the 15 pounder, which has a new screw breech mechanism. Several new features have been introduced into this design. Among them may be named the following:

First. Improved ejection by which the empty case, after firing, is thrown entirely clear of the breech as the gun is opened.

Second. The telescope sight is firmly fixed to the shoulder bar, and gearing between the bar and slide changes the angle between the line of sight, through the telescope, and the center line of the bore, so that when the telescope is brought to cover the target the piece is elevated for the range as ordered. This range is not shown on a bar, but is marked on a wheel showing the range (in yards) in large, plain figures.

A new semiautomatic gun is now under trial for use in the United States Navy. This is a 6 pounder, 50 calibers long, and in general appearance resembles the Hotchkiss.

The breech block is operated by a central cam lever pivoting below the block. There are two extractors, so shaped and operated that while they turn about a movable axis the head moves in a line parallel to the axis of bore. This piece, like the other 6-pounder, has a firing mechanism that can be inserted from the rear without removing the block from the gun, so that no face plate is required.

There are no screws about the moving parts, and though there are more parts than in the guns without the automatic features, still the mechanism is extremely simple. The block opens and the old case is ejected as the gun returns to battery. As the new charge is entered the block rises, the firing pin is retracted, and if the trigger is held back the piece is fired, or it may be fired at will, as desired.

The parts may be enumerated as follows: Block, extractors (2), operating lever; firing pin, firing spring, and guide washer assembled into one tactical piece; guide nut, bell crank; rocking sear and sear spring assembled in one tactical piece; closing spring and chain, opening cam, opening cam spring, trigger, and trigger spring. These are all the parts of the piece. Those assembled so as to remain together and capable of being removed from or put into place at one motion are counted as one tactical piece.

AMMUNITION.

The Gathmann Torpedo Company has again submitted its material for trials at Sandy Hook, but with results that proved nothing. The Navy has declined to make any further tests of the Gathmann system, on the ground that, even if successful, it could not be adopted for use in the Navy.

The Ordnance Bureau has taken a position on this matter that is entirely sound from every point of view.

It is a matter of no importance whether the so-called Gathmann shell will successfully carry its charge of high explosive beyond the muzzle of the gun or not. Shells loaded with gun cotton, and even with specially treated nitroglycerin, have been successfully fired from modern high-power guns.

Shells containing wet gun cotton have been fired through armor plates and the shell exploded after complete perforation.

In November, 1897, a 10 inch shell loaded with Jovite was fired through a 14.5 inch face-hardened plate of nickel steel. The shell, having a velocity of 1,860 foot-seconds, passed entirely through the plate and was exploded by the fuse in rear of it. A second 10 inch shell, only semiarmor piercing, was fired at a 16 inch plate. It penetrated to a depth of 12 inches and burst with great force. The velocity of the shell was 1,925 foot-seconds, and the charge of jovite in the shell was 28 pounds, showing conclusively that high explosives can and have been repeatedly fired from high-power guns with full charges and with complete success. But the storage of projectiles loaded with high-explosive charges in the magazines of a man-of-war introduces a different phase and by far the most serious one of this question. Until some stable compound can be found the Navy rightly retains black powder for shell charges, and from all we can learn black powder is the best. There may be times when the mining effect of a heavy bursting charge would be extremely valuable, but for 90 per cent of all the work required of shells, black powder is better than any high explosive. In armor-piercing shells this powder has not the force to break them up, but, on the other hand, the black powder will burst a light shell much better, shows the point of bursting better, and has more chance of starting fires.

THORITE.

Of all the explosives thus far tested for shell or torpedo charges thorite has given the most promising results. It is the invention of Dr. H. P. Tuttle, and its ingredients are known only to him and the board under whose direction the experiments were made. It is known, however, that the compound has in it no nitroglycerin and no picric acid. As tested it was in the form of a powder or fine sand. It has been placed under a charge of black gunpowder (but not confined in a gun) and the powder exploded without igniting the thorite. Red-hot irons have been thrust into it and rifle projectiles fired through it; in fact, every test has been applied to demonstrate its safety in handling and the impossibility of igniting it explosively in any way except by detonation. The ordinary detonator used in torpedo service detonates it with a force equal to dry gun cotton. How the compound will keep has not, of course, been sufficiently tested to warrant entire confidence in it as yet, for the reason that it has only been some two years since its discovery and something less than a year under trial. Some shells loaded with thorite have been sent to the Philippines for trial in service.

LYDDITE SHELL.

In the ammunition sent with the English troops into Africa last year was a small quantity of 5-inch howitzer shells loaded with 78 ounces of lyddite. Some of these were used in the campaign against Omdurman, and are said to have given excellent results, due to their great mining power. As a result it has now been determined to give each battery a limited quantity of shells loaded with this explosive.

In this connection may be mentioned the Sims-Dudley gun, designed to throw high explosives. A few of these guns were sent with the troops into the field during the war with Spain, but were so little used that but little could be learned of their efficiency in service. The system has been much improved of late, and a 5 inch gun lately tested at Sandy Hook has shown good results as a weapon for special service. As a result of these tests and the work done by the guns in Cuba, it is said that Russia is about to undertake extensive tests with a gun of this class of large caliber. The range of the 5 inch guns will be over 2 miles.

There is no doubt of the ability of the guns to safely discharge thin-walled shells loaded with dynamite, but the range is short and the necessary delays in preparing the shell and gun charges prevents anything like rapid firing. Besides, there are several compounds now in use that can safely be fired from high-power guns to distances three or four times as great, and these compounds when detonated have equal force, pound for pound, with gun cotton. There may be some loss in the necessary additional thickness in the walls of the shell, but this loss is more than made up by the gain in range, rapidity of fire, penetration, and simplicity of the high-power guns.

Several Sims-Dudley guns of 2.5 inch caliber have been sent with the troops to the Philippines, where their small weight will doubtless show to good advantage in transportation.

TORPEDOES.

The effort to make the Whitehead torpedoes maintain a straight course still continues, and if reports are correct this glaring defect has been overcome.

It was thought that the Obry attachment to the steering gear would keep the torpedo on the course in which it was pointed from the tube, but unfortunately this hope has not been entirely realized. The device has been improved in the United States, and it is said that good results have now been obtained, though no data are at hand from this country. We have, however, some results obtained with a German device tried at Kiel in the early part of the year. This device is the invention of Mr. Kaselowsky. While the data are not obtained from any official source, they may be taken as fairly accurate.

The general principles of the design are like those of the Obry attachment. That is to say, depend upon the gyroscopic action of a rapidly-revolving wheel, connected by gears to the steering rudder. Unlike the Obry, however, which uses a spring to impart motion to the wheel, this gear is actuated by an under and over shot wheel, the buckets of which receive a jet of air from the flask of the torpedo.

The torpedo is said to have maintained a straight course for a distance of 1,500 yards. The tube from which the tests were made was 9 feet above water. A torpedo launched from this showed at a range of 1,000 yards a divergence of but 6 yards out of twenty-three trials. That is to say, all of the twenty-three shots hit a target of 6 yards' length at a distance of 1,000 yards.

The trials were made on six days and covered many changes of weather, the sea being rough part of the time. Though the account of this trial does not mention it, it is taken for granted that it was made while the ship was not moving through the water.

To test the efficiency of the regulator when used in a torpedo fired from the broadside of a moving vessel, several torpedoes were fired from the launching tube of torpedo boat *No. G 88*, while running at a speed of 22 knots. These shots are said to have given most satisfactory results, the maximum deviation in 800 yards not exceeding 2 yards in lateral train.

If these results have actually been obtained, it will go a long way toward making the Whitehead torpedo a weapon of precision.

The necessity for a device of this kind is plainly shown by the many accidents that have occurred in torpedo target practice. The last of these that has come to my notice occurred at Malta last spring, during the target practice with Whitehead torpedoes, from the English ship *Scylla*. The torpedo, instead of making a course for the target, turned and came back toward the ship, which was at anchor with the steam pinnace at the boom. This boat was struck amidships by the torpedo with such force as to enter through the side into the engine space, seriously wounding the fireman, and remained fixed in that position, sinking the boat. Fortunately, the crew were rescued. Had the pinnace not been in the way the ship might have been badly damaged, if not sunk. Is it any wonder, then, that efforts are being made to keep this weapon pointed toward the enemy? Of course the torpedo only had the exercise head on, but with the war head the result would have been very serious.

RAPIDITY OF FIRE AND GUN TRIALS.

Among the interesting trials that have taken place during the past year was one conducted at the Naval Proving Ground with two of the guns of the *New Orleans*. It will be recalled that these were built by Armstrong, 50 calibers long, and represented the very latest thing in ordnance of the class. The two guns were respectively 6-inch and 4.7 inch caliber. The ammunition supplied with the guns was cordite, but as this powder is not manufactured in this country and we could hardly be dependent on a foreign country for further supplies, it became necessary to determine a suitable loading of our own powder for the guns. Incidentally, the firing brought out some interesting facts.

The cordite charge for the 6-inch gun is 18.65 pounds, the projectile, like ours, weighing 100 pounds. The muzzle velocity for this loading is between 2,504 and 2,534 foot-seconds. The guns were sighted for 2,650 foot-seconds with a chamber pressure of 15 tons. The loading, however, gave only about 14 tons pressure, showing that for some reason the powder had fallen off in strength.

With our own Navy powder, 26 pounds gave 14.8 tons pressure and a velocity of 2,576 foot-seconds, showing that our powder was not so strong as the English, but that by increasing the charge the same result could be attained with but slight increase in pressure.

The 4.7 inch gun, 50 calibers long, from the *New Orleans*, with a charge of 8.5 pounds of cordite, gave an average muzzle velocity of 2,549 foot-seconds with 14.4 tons chamber pressure. The projectile weighed 45 pounds. A charge of our own powder of 13.5 pounds gave a muzzle velocity of 2,606 foot-seconds and chamber pressure of 14.6 tons.

From both these firings it will be seen that it requires about 50 per cent more of our powder to produce the same velocity of projectile, with but little increase in pressure, and not in excess of that allowed, viz, 15 tons. Cordite has a large percentage of nitro-glycerine, which is an element of danger, while our Navy powder has none; and though a large increase in the charge is necessary to give the same result, it seems to me that as long as the result can be attained the weight of the charge is of but little consequence. On the other hand we have the advantage of using a much safer compound and one that will give more regular velocities.

On this subject we have some interesting data from the report of Capt. A. B. Juel relating to the charge, velocity, and pressure obtained in proof firing two 25 centimeter (9.84 inch) guns built for the Swedish navy.

The two guns were built by Schneider & Co. and were probably 45 calibers long, though that figure is not mentioned in the report. The table of firing follows:

Number of gun.	Weight of projectile.	Charge.		Velocity.	Gas pressure
		Kind of powder.	Weight.		
	Kilograms.		*Kilograms.*	*Meters.*	*Atmospheres.*
3	205	B. M. 13.	58	785	2,493
3	205	....do...	54	736	2,190
3	205.2	....do...	53	731	2,133
3	205.2	....do...	52	713	1,965
3	205.2	....do...	63	830	2,817
3	205	....do...	64	843	2,950
4	204.5	....do...	52.65	720	2,072
4	205	....do...	52.65	722	2,049
4	205	....do...	52.65	722	2,032
4	205.9	....do...	64	850	3,187
4	204	....do...	63.5	847	3,072
4	206	....do...	52.65	723	2,116
4	206	....do...	52.65	717	2,084
4	205.9	....do...	52.65	717	2,056

Hence with powder charges of 52.65 kilograms the average attained in six rounds was 720.1 meters initial velocity, with 2,068 atmospheres gas pressure. The smokeless powder used, B. M. 13, was from the French powder factory at Sevran-Livres, and was the kind used in the French navy. It was in the shape of cakes 290 millimeters long, 45 millimeters wide, and 3 millimeters thick. The cakes were tied together in cylindrical bundles of about 240 millimeters diameter. Either two or three of these bundles were introduced into the same cartridge, so that a charge consisted of five bundles distributed between two cartridges. As this powder answers the requirements as to ballistics, and as far as now known is durable and causes comparatively little wear on the bore, a first supply of the same has been ordered for the battleships *Thor* and *Niord*.

This interesting report, in dealing with the subject of rapid-fire and automatic guns, contains some paragraphs which we quote in full, as follows:

37 MILLIMETER R. F. GUN M/98.

The 25 millimeter machine gun, which for a period of almost twenty years occupied a foremost position among our rapid-fire guns, and which during that time has formed part of the armament of almost all of our warships, can no longer fulfill the increased demands as to effectiveness and good working, and is therefore being everywhere forced out by more modern weapons. For warding off torpedo-boat attacks it has long since been replaced by the 57 millimeter R. F. gun. For the armament of first-class torpedo boats it has recently been succeeded by the 47 millimeter R. F. gun, and for the armament of fighting tops by the 8-millimeter automatic machine gun, so that at the beginning of the present year it was only for the armament of second-class torpedo boats and steam launches of battleships that the 25 millimeter machine gun has not yet been given a successor.

There remained doubts, however, as to the suitability of the 47 millimeter gun for torpedo-boat armament, as well as of the 8 millimeter machine gun for fighting tops, and when it was suggested last year to test a 37 millimeter Maxim automatic machine gun, hopes were entertained that this gun might possibly furnish a weapon which would be equally suitable for the armament of torpedo boats, steam launches, and fighting tops, or at least in most cases. And as since the introduction of the new coast-defense instructions it had proved necessary that the rapid-fire gun should be adapted for use ashore as well as on board, it was decided to try the 37 millimeter automatic gun in that respect, and a committee was appointed to carry out the trials and report thereon.

The committee met in December of last year, and its report shows that the 37-millimeter machine gun was tested as to its automatic firing, good working, and penetration; also as to its suitability for the armament of torpedo boats and first-class steam launches of battleships. The trials showed that the capacity of rapid firing depended to a high degree on the quality of ammunition, which must be manufactured with even greater accuracy than is required for other rapid-fire guns. From the number of hits and the 50 per cent deviation, it was shown that the accuracy of fire when firing shot by shot, that is to say, not automatically, was not satisfactory even at 1,000 meters, and with automatic firing still less so. The power of penetration was found sufficient. For the armament of steam launches the gun was found to occupy too much space and to be too heavy, thereby reducing the seaworthiness of the boat. The automatic gun was reported suitable for the armament of torpedo boats, but not for fighting tops; as a landing gun, it was found to be too cumbersome for transportation and too heavy to be set up ashore.

In its conclusion, the committee says that "the question toward the solution of which the firing trials with the 37 millimeter automatic gun were to contribute, namely, the requirements of a weapon suitable for the armament of torpedo boats, steam launches, fighting tops and as a landing gun, should be solved in that direction, and that therefore—with strict adherence to uniformity; that is to say, the same gun to be used for all the purposes mentioned—the committee recommends the acquisition of a 37 or 38 millimeter R. F. gun located in a recoil jacket, the total weight with recoil jacket to be about 100 kilograms." The gun was to have self-igniting cartridges with explosive shell, the weight of the latter to be as large as compatible with the type of gun, the initial velocity to be 550 meters.

When this question had been decided manufacturers were called upon for proposals and the gun submitted by Bofors was accepted under the designation, 37-millimeter R. F. gun, M 98. The following figures will give an idea of its characteristics and construction.

Caliber	millimeters	37
Length of gun	do	1,368
Length of gun in calibers		37
Number of grooves		16
Depth of grooves	millimeters	0.3
Twist of rifling at muzzle	caliber	60
Twist of rifling 185 millimeters from muzzle	do	30
Volume of bore	decimeter³	1.42
Transverse area of bore	centimeter²	11.02
Volume of chamber	decimeter³	0.152
Normal recoil	millimeters	180
Maximum recoil	do	200
Weight of projectile	kilograms	0.8
Initial velocity	meters (about)	550

Energy at muzzle	meter-tons	12.3
Penetration at 1,000 meters	millimeters	41
Penetration at 2,000 meters	do	29
Weight of gun with mechanism	kilograms	67.5
Weight of recoil jacket	do	27
Weight of gun and recoil jacket	do	94.5
Weight of shoulder-piece, with sight and firing device	do	4
Weight of pivot mount	do	9
Weight of gun complete with pivot mount	do	107.5
Weight of cone (36 kilograms) and ring (20 kilograms)	do	56
Total weight	do	163.5

It was further ordered that the torpedo boats *Orkan*, *Vind*, and *Bris* should each be equipped with two guns of this type, and all second-class torpedo boats to be built should each be equipped with one such gun. The adoption of the 37 millimeter gun as a landing gun has not yet been decided, because the nature of the proper mount for such gun can only be determined after practical trials. * * *

As to the 21 centimeter guns, the requirements are that the total length shall be 45 calibers, the weight of projectile 140 kilograms, and the initial velocity 700 meters, the gas pressure in the powder chamber not to exceed 2,100 atmospheres. The mount is to consist of a recoil jacket which, with the pivot, is to rest on a foundation in the turret, and provided with devices for checking the recoil and for automatic return to battery. The length of the recoil is to be about 500 millimeters. When the guns are delivered they are to be tried, among others, as to their rapidity of fire, and it shall be required that, with the weight of projectile and initial velocity above specified, three rounds can be fired in one minute, the time to be reckoned from the report of the first to the report of the third shot.

As to the 15 centimeter guns, the total length is to be 45 calibers, the weight of the projectile 45.4 kilograms, and the initial velocity 750 meters, the maximum gas pressure not to exceed 2,100 atmospheres. No cartridge cases are to be used; the charge is to be inclosed in a cartridge and the closure is to be effected by means of the de Bange gas check, the same as in the Vickers 15 centimeter R. F. gun. The mount is to be, on the whole, of the same construction as for the 12 centimeter R. F. guns, and is to be equipped on both sides with wheels for lateral training as well as for elevating. The rapid-firing capacity of the gun is to be tested upon delivery. The requirements are that six rounds with war ammunition can be fired in one minute, the time to be reckoned from the report of the first to the report of the sixth shot.

ARMOR.

It may be said that but little if any progress has been made in the improvement of armor during the year. The trials that have taken place have simply still further established the superiority of the Krupp process beyond any question, and until some new inventor comes forward with a process for hardening and toughening the plate which is cheaper or better, the Krupp armor will be standard for all navies. It is being manufactured by some fourteen firms, practically covering all the armor factories of Europe and America. The resisting power is about one-fourth greater than that of Harveyed nickel steel; or, retaining the same armor protection, there is a saving of about one fourth in weight, thereby permitting an increase of battery, or engine power, or coal capacity, or decrease in draught, or any or all of these advantages.

This means a saving of weight for a battleship of about 600 tons, or equal to some forty 6 inch guns with their carriages.

An interesting comparison was lately made in England which does not place the Krupp process quite so far above the Harvey in resisting power, but still showing a marked advantage. This shows the following plates to have equal resisting power, viz:

	Inches.
Wrought iron	14
Compound steel	11
Harvey nickel steel	7
Krupp nickel steel	6

A far more complete table has just appeared in the Annual Report of the Chief of the Bureau of Ordnance of the Navy, and, though mainly computations, it is based on results obtained on trials and is undoubtedly accurate. The table follows:

Table of elements of latest types of naval guns (models of 1899), giving perforation of face-hardened armor at ranges up to 3,000 yards, with smokeless powder and uncapped armor-piercing projectiles, at normal impact.

Caliber of gun.	Length.	Weight.	Weight of projectile.	Muzzle velocity.	Muzzle energy.	Perforation at muzzle, Harveyed nickel steel.	Perforation at muzzle, Krupp armor.	Remaining velocity at 1,000 yards.
	Caliber.	*Tons.*	*Pounds.*	*Foot-secs.*	*Foot-tons.*	*Inches.*	*Inches.*	*Foot-secs.*
3 inch	50	0.87	14	3,000	874	4.19	3.35	2,328
4 inch	50	2.56	32	3,000	1,999	6.12	4.90	2,477
5 inch	50	7.4	60	2,900	3,503	7.51	6.01	2,460
6 inch	50	8	100	2,900	5,838	9.35	7.71	2,516
8 inch	45	18	250	2,800	13,602	13.57	10.66	2,531
10 inch	40	33.4	500	2,800	27,204	18.57	14.86	2,587
12 inch	40	52	850	2,800	58,221	23.42	18.74	2,619

Caliber of gun.	Perforation at 1,000 yards of Harveyed nickel steel.	Perforation at 1,000 yards of Krupp armor.	Remaining velocity at 2,000 yards.	Perforation at 2,000 yards of Harveyed nickel plate.	Perforation at 2,000 yards of Krupp armor.	Remaining velocity at 3,000 yards.	Perforation at 3,000 yards of Harveyed nickel steel.	Perforation at 3,000 yards of Krupp armor.
	Inches.	*Inches.*	*Foot-secs.*	*Inches.*	*Inches.*	*Foot-secs.*	*Inches.*	*Inches.*
3 inch	2.98	2.38	1,806	2.13	1.70	1,401	1.52	1.22
4 inch	4.77	3.91	2,046	3.68	2.94	1,690	2.85	2.28
5 inch	6.03	4.82	2,087	4.85	3.88	1.771	3.89	3.11
6 inch	7.74	6.19	2,183	6.40	5.12	1,893	5.30	4.24
8 inch	11.86	9.49	2,288	10.37	8.30	2,068	9.06	6.61
10 inch	16.71	13.37	2,391	15.04	12.03	2,209	13.53	10.82
12 inch	21.42	16.84	2,450	19.60	15.68	2,291	17.92	14.34

With capped projectile an increased thickness of from 15 to 20 per cent may be perforated.

V.

TARGET PRACTICE ON SHIPBOARD.

Translated from La Marine Française.

It is indisputable that our officers and ships' companies expect the very best results from our batteries, and they are quite justified as concerns the matériel, the constant development of which during the last thirty years has placed us considerably in advance of our rivals.

As for the personnel, the training of gun pointers has been the object of constant solicitude for many years, and at the present time, while we are giving particular attention to the theory of target practice and a closer analysis of the results obtained, we are forced to acknowledge the wisdom and the exactness of the practical rules which were in use on the *Louis XIV* and the *Alexandre.* The directions for firing on the roll, which date back fifteen years, have not aged a day. The experiences gained by practice were summarized with remarkable clearness, and the use of perfected guns has not lessened their value. Our officers, who have had many occasions to verify the coolness and skill of our gunners, were surprised at the results of practice on a large scale under circumstances resembling actual war conditions, and they with difficulty admitted that unexpected phenomena—unskillfulness of the gun pointers, or rather the defective methods of the instructing officers—have not rendered them inferior to what they expected,

There has resulted a distrust all the more regrettable because it reflects on the methods employed by certain gunners, who, having accomplished on mathematical principles what their predecessors arrived at by plain common sense, have believed in good faith that they have revolutionized the art of target practice on board ship.

What has been the use of all the millions spent by our squadrons if the results of their experience are not considered as so much gained; if the Admiral of the West suspects the results obtained by the Admiral of the East; if a commander only accepts conditionally the rules laid down by his predecessor?

Will it not be a useful work to show in all sincerity that the controversy turns on words and definitions; that there are not two ways of firing a gun, but only one?

We believe that we are authorized to make the attempt because we have witnessed the squadron target practices under Admirals Gervais and Cuverville, the actual war practices under Admiral Bienaimé in Madagascar, a period of instruction on the gunnery school, and finally and above all, because we are independent. We wish to recall those facts and ideas which can not be contested, and which should, we believe, show that the schism among the gun pointers is, after all, only personal antagonism.

The first practical target practice against a hulk was due to the initiative of Admiral Aube. Admiral Lafont, who was detailed to carry it out against the hulk *Armide*, did not anticipate the possibility of our gunners hitting the vessel at 3,281 yards.

We see that the commander in chief of the fleet at that time was far from sharing the illusion, still so universal, concerning the degree of efficiency of guns on board ship. The experiment succeeded beyond his hopes, showing 23 per cent with black powder, the smoke of which masked the target.

Admiral Gervais, in 1895, obtained first 26 per cent, then 19 per cent, firing at ranges varying between 2,500 and 3,000 yards against the hulk *Fourmique de Giens*. In 1896 he obtained 30 per cent under the same conditions.

The same year the reserve squadron under Admiral Cuverville made 35 per cent; two months later, 30 per cent, and in June, 25 per cent.

From the comparison between the results obtained by different officers and crews comes the conviction that they have an inherent value, and that there is no necessity of lamenting their mediocrity. It seems more logical to candidly accept the results of these experiments. These results are such as we may expect under average circumstances while using a small quantity of ammunition. When everything is admirably prepared and all chances are favorable, we may reach 56 per cent, as the *Duperré* made against the *Fourmigne* in 1896, but we have no reason to always anticipate such results.

We determine from these practical exercises an experimental value of efficiency. If the analysis of the circumstances of the target practice is correctly made, there should result an agreement between practice and theory.

Let us attempt this analysis:

We know that a rifle solidly secured and pointed at a small distance from a target, and supplied with the best ammunition, will not give a single point of impact, but a group of points, the dispersion of which will depend upon the quality of the piece.

The result is that a marksman duplicating a first shot has rather alarming luck.

Or again, a well-aimed shot may very well miss the bull's-eye, which is always smaller than the maximum dispersion.

Install a gun on shore, and fire the first shot with a known elevation, then a second shot under conditions as identical as possible, with the object of striking the first point of impact. We will doubtless miss it, though the distance was correct, being the same as for the first shot.

There is not an officer who does not know this; nevertheless, when at a well-regulated target practice a gun pointer fails to hit the bull's-eye, there are very few who abstain from unfavorable comment.

What can be more discouraging for a man who has an absolute and jealously maintained confidence in his piece, and who feels sure that he only fired after getting a perfect aim?

He will come to suspect the elements of the pointing which do not depend on him—that is to say, the distance and elevation given by the gunnery officer.

If, on the contrary, he lays a line of sight that is defective, through an exaggeration of the front sight taken, or through aiming off the target, the possibly successful result can only encourage him in such an unfortunate practice. He will have too much respect for discipline to change on his own authority the prescribed elevation, but he nevertheless modifies it indirectly, and what is worse, does so in such a manner that it escapes valuation, and precludes the possibility of correcting subsequent shots.

It is a singular method that destroys the reciprocal confidence between the officer and the gun pointer under the pretext of not casting discredit on the matériel.

It can not be too often impressed on the gun pointer that a shot which has been very well aimed may be unsuccessful, and inversely that a badly aimed shot may strike the target.

That does not mean that the pointers who shoot away the most targets are not the best, though theoretically they should carry away even more.

An ideal pointer who lays a piece on shore with the precision of the spirit level will not of course place each shot at the point where the first shot strikes. But there does not exist a pointer who can lay a piece with the precision of a spirit level. Admiral Bienaimé was able to verify this at Fort Tamatave, where the aiming of two 5.5 inch pieces was checked by the use of the level. In the pointing exercise at the gunnery school the triangle pricked through the card should not be more than 0.8 inch on a side. At the distance at which this exercise is carried out, this corresponds to an angle of about 7 minutes. Generally our pointers lay the line of sight at less than 7 minutes. Lieutenant Laporte, in examining a large number of records of the schoolship target practice, has deduced a mean value of 3 minutes as the error in the elevation given to a piece, due to the greater or less amount of the front sight taken (it depends besides on the distance between the front and rear sights).

If one also remarks that the elevation given to a piece varies again from one shot to another with the point of the target aimed at, particularly when the target is not clearly defined, we understand that our pointers, considered as aiming instruments, are more imperfect than we generally suppose.

The truth of this assertion is proved by the fact that, since the existence of officer pupils on board the *Couronne*, at their first exercise with service charges in the competitive prize firing, they at once obtain a higher average than the men, and that simply because their more refined judgment enables them to more exactly seize the line of sight.

All the preceding applies to the gun pointer on shore firing at a fixed target, where, as a certain officer has said, you may leave the piece in position at sundown and fire it at reveille without inconvenience.

When the piece and the target are in motion, a new element has to be taken into consideration—that is to say, the lost time which elapses between the instant the pointer has brought the line of sight on the target and the instant he succeeds in igniting the primer. This is independent of the delay in igniting the charge due to the action of the mechanical devices used.

In regular practical instruction, we observe by checking the pointer's aim that he pulls the lock string or trigger an appreciable time after the tip of the front sight, the notch, and the target are in line. The coolest-headed men lose less time than the others. Astronomers themselves have their personal equations, so that it is not to be wondered at that Jacky does not pull the lock string at the exact moment when the well-known image of a good aim is projected on his retina. The lost time will be increased when the lack of distinctness of the object is a cause of hesitation.

What would be the influence of this lost time, of which the average duration is one-half of a second?

A relative speed of 30 knots would correspond to a displacement of less than 26 feet at the target in that interval; and the largest target having always greater dimensions than that, and the errors arising from other causes being much more considerable, it may well be neglected. But the variations of the angle of elevation due to rolling or pitching has on the contrary important consequences, and all the more so that the trajectories are now much flatter. If the lost time is sufficient to allow the vessel to roll 2½ degrees, a 6.5 inch gun, model 1884, laid for a distance of 2,187 yards, will land its projectile at 3,937 yards. This enormous error shows the advantage of stability of platform, and the necessity of a special training, and an instantaneous firing apparatus for the armament of cruisers.

Pointing proper, or the knowledge of how to adjust the line of sight on the target, is the simplest part of the instruction of a gun pointer;

the simultaneous action of discharging the piece demands still more prolonged efforts; the development of a sure and correct eye, a judgment which anticipates the movements of oscillation, and finally coolheadedness.

It is the combination of all these qualities which makes the gun pointer, and it is not sufficient for him to have good eyes and to take a fine sight. The instruction on board the gunnery school ship, the methods of which are established by long experience, has succeeded in developing all this with a minimum expenditure of costly ammunition. A qualified gun pointer during the eight months of schooling fires a maximum of thirty projectiles. He is prepared on board, in a general way, for firing; but if he is required to fire a piece from a closed turret, he has to receive a special education, and the same if he is made chief of piece on a small vessel whose movements at sea are rapid.

Practice against a hulk can only take place from regular men-of-war.

The following table, calculated from several thousand shots fired at anchor from the school ship, at distances accurately known, and with every guaranty of accurate marking, permits us to arrive at the falling off from the theoretical percentage due to substitution of the pointer for the spirit level in giving elevation to the piece:

Calibers.	Per cent observed.	Per cent from tables.
6.3 inch R. F., model 1884	18	32
5.5 inch R. F., model 1884	8	21
4 inch R. F., model 1884	6	19
5.5 inch, model 1870	4	22
9.5 inch, model 1870	15	23
10.6 inch, model 1870	15	26

This permits us, therefore, to appreciate the influence of the pointer in the firing problem—the amount of rear sight being fixed, and the target constant—which should theoretically assure the permanence of the angle of elevation. The zone of dispersion of the shots is much more extended than we would be led to suppose by a simple examination of the tables. The knowledge of the average deviation that they show, which gives an idea of the actual extent of the zone of dispersion at the Gâvres proving ground, gives only a minimum limit, and an attempt to base on them the probabilities of striking the target could only result in delusion.

Leaving the pointer out of the question, we would not be justified in assuming that the average deviation observed at the proving ground would be the same as the average of a piece mounted on board ship.

The causes of the accidental deviations which produce the dispersion of the shots are as follows: The variations of the angle of bearing due to the elastic reaction of the platform, which may have a very different value for the same piece, according to the installation; the variations of initial velocity depending on the amount of wear of the bore, which does not cause a regular diminution of velocity, as is proved by the irregularity of the results obtained with a much worn piece which is used after repeated firing on board ship, whereas on the proving ground pieces are always new.

We see, therefore, the danger of relying solely on theoretical conjecture based on tabulated results. This is still further augmented by the fact that an inexact interpretation of the theory of probabilities may lead us to admit a larger percentage than is justifiable from a limited number of shots.

A probability of 10 per cent does not indicate by any means that out of 100 shots there will be 10 hits. That would only be true for an infinite number of shots. It is only a long series of shots, as on the gunnery school-ships, that will give results comparable to the theoretical probability.

We have thus far insisted on the following points:

The gun itself, everything else being equal, has not the efficiency which we are inclined to give it. By its necessary association with the pointer, no matter how well trained he may be, its efficiency is still further diminished.

The information in the firing tables designated as the probability of hitting the mark has no absolute value. It defines the efficiency of a piece firing on a level an infinite number of shots.

The minimum deviation, as given by the proving-ground tables, is about 32.8 yards for modern artillery, and is practically independent of the distance; which means only that the deviation is practically the same for the ranges used on the proving ground, which are all in the neighborhood of the efficient range of the piece. It is easy to calculate what this deviation will become through the intervention of the pointer. To the accidental deviation of the initial velocity and the angle of the line of sight are to be added the variations due to the fineness of the sight—that is to say, to the amount of the front sight appearing in the notch. These variations are smallest with the large calibers, where the distance between the sights is greater; but, on the contrary, large projectiles are more sensible than small ones to changes of initial velocity. We find that a piece mounted on shore and aimed at the same point with the same amount of rear sight by one of our gun pointers will have a zone of dispersion of about 54.6 yards, which gives about 328 yards in depth. Instead of one gun pointer, if we consider several, firing with identical pieces, the zone of dispersion remains 328 yards, if they all aim at exactly the same point; but if they do not it will be increased in the same manner as if a single pointer were aimed first at one point and then at another, thus varying the firing angle. This is what usually takes place if the target is not well defined. Admiral Gervais having directed the pointers to aim at a point halfway up the hull of the *Fourmigue de Giens*, the observers at right angles were able to note the elongation of the zone, and the consequent decrease in density, and to measure its value. The average deviation was about double what it should have been. We may therefore lay down as a principle, without conjecture as to whether the point to be aimed at is the one we propose to strike, that it should be of such a nature as to be designated without ambiguity and easily brought into the line of sight.

Supposing, therefore, our gun pointers on solid ground and carefully pointing their excellent pieces, all the shots will be grouped in a zone of 328 yards in depth. It immediately follows that if about the central point of the group we imagine a band narrower than this zone there will be shots that will miss it. This will not be the fault of the gun pointers, nor will it any more be the fault of the officers, who play no rôle in the circumstances we are discussing. The theory of probabilities indicates the deviation of the shots into a zone of dispersion. This was verified experimentally by the firing of 10,000 shots at Toulouse with a Gras rifle secured in a block of cast iron to insure its pointing in an invariable direction.

If the imaginary band has for its half width the probable deviation for an infinite number of shots, half of them only will strike it; and if we only fire a limited number we will have an infinitely small chance of lodging precisely half the projectiles in it.

If instead of considering a horizontal band we suppose a vertical one of a given height erected at the nearest limit of the zone of 328 yards, and if we join the top of this band to the farthest edge of the zone, we will have a limiting direction, or a value of the angle of impact above which a part of the projectiles which fall in the zone of 328 yards will pass over the vertical band.

Imagine a battleship placed beam on at the position of the target, and we see that a 6.5 inch gun, model 1887 or 1891, will only reach her with all its shots at a distance of 3,062 yards; a 5.5 inch of the same models, at 2,624 yards. These limits fall respectively to 2,406 yards and 1,968 yards, for the 1884 models of these two guns.

But this dispersion of the shots takes place only in depth; the grouping has also a width dimension, due to the imperfection of the direction angle, which is an angle of about 3′—value deduced from the target practice of the schoolship. If we place a battleship end on with its central point in the center of the zone of dispersion there will be shots which pass clear of the vessel to the right or left as soon as the 3′ disperse the shots at more than 21.8 yards from the center, which will take place at a distance of about 3,281 yards. At 6,560 yards 77 per cent out of an infinite number of shots will be good in direction, and since for the 6.5 inch, model 1887, at this distance 50 per cent only will be good in range, there results a combined probability, the product of these two chances, equal to 37 per cent[1]—this with the piece on shore, a fixed target, and the practice perfectly regulated, to use an unlucky expression.

If you will take into consideration now the augmentation of the zones of dispersion when the pieces are mounted on board ship, that they are under different commands, that their ammunition is not absolutely identical, that they are subject to the rolling and pitching movements and to the excitement of the gun pointers, and if we remark that it is by pure fiction that we have placed the objective in the center of the zone of dispersion, that it will not come there by itself, and that the operation which consists in grouping the shots around the target is necessarily subject to errors and uncertainties, then will we understand all the wisdom of the official document issued by the artillery department, which only leads us to expect serious results from the following ranges:

	Yards.
3.9 inch, model 1881	1,640
3.9 inch, model 1891	2,843
5.5 inch, model 1884	2,187
5.5 inch, model 1887–1891	2,843
6.5 inch, model 1884	2,624
6.5 inch, model 1887–1893	3,496

In order to see what will become of these probabilities of striking the target, already so much reduced by an examination of general principles, we must consider the rôle of the officer in charge of the firing and his assistants.

The distance of the point of impact depends principally on the angle of elevation. The rear sight is nothing but an instrument of angular measure, which might very well only be graduated in degrees. With various angles of elevation at the Gâvre proving ground they found experimentally the various ranges, which for convenience are indicated on the rear sight, and by interpolation give the distance graduations. In the first place, it is evident that the piece when mounted on board ship and firing under different conditions will have a small chance of reproducing, with the same angles of elevation, the ranges at Gâvre. Nobody is ignorant of this; therefore absolute faith in the range, carried to the point of blaming the pointer or the ammunition, when, being perfectly well known, that it does not produce good results—or, inversely, of suspecting the measurement of the distance when the shots do not approach the target—is rare enough.

It does not follow, however, that the range has no value in practice. It constitutes the first approximation of the angle of elevation to employ, and it is at least logical to adopt it, as daily experience shows. We should neither despise it nor pin our faith to it.

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[1] This probability falls to 9 per cent if we suppose a deviation of 137 yards (always for an infinite number of shots).

Suppose the constant perfectly well known, and let us evaluate the influence of the divers circumstances which may have been modified since the firing at Gâvre.

The resistance of the air depends on its density, which has chances of not being the same. The $\frac{\Delta d}{\Delta}$ hardly exceeds one-tenth, which for the 13.4 inch, model 1887, gives 87.3 yards difference in range with the rear sight at 4,373 yards. The initial velocity communicated depends on the temperature that the cartridges may have been subjected to in the magazine. If this temperature has not exceeded 104° F. we may anticipate an augmentation of 14.2 yards, which corresponds to about 109.3 yards increase in range at 4,373 yards—this always for the 13.4 inch gun. The wear of the bore of the piece has an influence which is impossible to anticipate a priori. Experience only permits us to determine the correction.

The wind, by its component parallel to the line of fire, displaces the point of impact. Supposing that this component should be 5.4 yards per second, and combining its effect with the one we have just examined, neglecting the correction for wear, we find that an average range of 4,373 yards at Gâvre may be augmented by 174.9 yards under these conditions. The wear of the piece, and all the causes cited acting in an inverse direction, may diminish the range more than this.

In other words, the zone of dispersion of the shots may be displaced by from 174.9 to 218.7 yards by systematic causes, this zone of dispersion being itself open to 328 yards, on an average, by accidental causes. We immediately see that an objective which includes all the shots at Gâvre will only receive in the same respective position a more or less reduced fraction of them.

But the range is not generally known a priori, and it is necessary to measure it.

The error in this measurement will again displace the center of the zone of dispersion.

If the range is deduced from the angular measure taken at the masthead it is subject to two errors:

First, the error of the height in feet;

Second, the error in the angle measured. This latter error, being supposed to be one-half minute, will falsify the distance by 196.8 yards at 6,560 yards, or by 49.2 yards at 3,281 yards, with the height of the observer at 98.4 feet. If the height of the observer is in error by say 6.5 feet out of the total of 65.6 feet, the calculated distance will be in error by one-tenth; that is to say, by 437.3 yards out of 4,373.

The second method of measuring distance, by the depression, seems at first sight more exact, and all the more exact the higher the observer is placed, which has led those officers who attach an extreme importance to the measure of the distance to lay down as a principle that the accuracy of the practice depends on the height of the mast. In this last method the first uncertainty is in the height of the observer, which error may well be as much as 1.6 feet, and which for 65.6 feet of altitude causes alone an error of 109.3 yards in 4,373. As for the angle, we must not expect to measure it with an error less than 1′, according to the admission made by Admiral Bienaimé in an unpublished work.

An error of 1′, with the observer at a height of 65.6 feet, will cause an error of 156.4 yards in 3,281, of 273.4 in 4,373, and of 721.6 in 6,560.

The resultant is 382.6 yards in 4,373 for an observer at a height of 65.6 feet; that is to say, about one-tenth of the distance measured.

We will cite as a memorandum the English telemeter, which we believed should be tried in a squadron. They substitute a base of 6.5 feet at a maximum for a base of 82 or 98.4 feet. It is not difficult to foresee the result.

We see finally that if the piece embarked on board ship has retained the ranges which it had at Gâvre it would still be impossible to give exactly the required angles of elevation. At the very outside we may be sure that the point of impact will be removed from the target by more than one-tenth of the total range. But having to take into account the systematic deviation of about 218.7 yards, if all the causes of variation act in the same direction, we may find very considerable dispersions at the target, reaching as much as 656 yards, as shown by experience. No one has a right to be surprised at this after having examined all the documents bearing on the subject. But in general there is established a sort of equilibrium between these various influences, and the first shots fired are not so very far from the target.

It is also necessary to take into account that the vessel and target are both in motion in order to appreciate the real conditions under which the firing must be regulated.

The first result of the motion of the objective is to modify the distance during the time of flight of the projectile. Since the projectile participates in the motion of the vessel, we need only concern ourselves with that of the target. If it is a battleship and we guess the speed as 12 knots we will not be out at the most by more than 5 knots or 82 feet displacement after ten seconds of flight.

But the principal consequence is to sometimes change the distance so rapidly that, in order to use it a certain time after it has been determined, we must correct it for the lost time between the measuring of the distance and the firing of the shot.

If we make a mistake of ten seconds in this lost time, we will have for a relative speed of 15 knots, which is not exaggerated, a change in distance of 136 yards—that is to say, a new systematic error which is far from being negligible. Supposing the height of the mast to be 82 feet, and the vessels approaching or receding at a relative speed of

10 knots, and adding or subtracting the supposed mean error for all the circumstances enumerated, we can easily calculate that at a distance of 2,187 yards we may expect to see the center of the zone displaced 295 yards from the target. This zone, being supposed to be obtained by the simultaneous fire of a great number of pieces (in order to remove the objection of the relative displacement from one shot to another), will have an extent of about 328 yards, and the proportion of shots which take effect will be exactly nil.

Having managed everything very well, the result will be a miserable target practice.

This case only happens when we have all the chances against us—that is to say, bad luck, but that can happen. May this render you respectful to the percentages of your comrades.

In the practice of Admiral Gervais' squadron the average deviation at the center of the target was between 65.6 and 109.3 yards. The same results were obtained in the practice from the *Couronne* (schoolship) at 3,280 yards under way. The "young gun pointers" did no better against the *Petrel* (hulk).

What might be the result of the influence of the deviation of 109.3 yards on the chances of hitting?

For the 5.5 inch model 1884, at 4,373 yards, the theoretical probability of 50 per cent falls to 9 per cent for a deviation of 137 yards.

We see, therefore, in the first place, that theory verifies the experimental percentages, and that, on the other hand, the innovators and the routine men accomplish about the same results, regulating their fire to about 109.3 yards.

An officer in charge of firing, without special information and relying only on ordinary common sense, sets his rear sight according to the measured distance, and is careful to observe where his shell falls. If he observes that the target does not appear to run any risk, he keeps changing the rear sight until he obtains better results. What difference does it make if he attributes this necessary change to an inexact measurement of the distance, so long as he proceeds as he should? He does not always remember that the firing tables show how little a few hundredths of an inch on the rear sight displaces the average point of impact. He may therefore observe that a shot falls short after a too timid augmentation of the elevation. The two zones of dispersion being partially superimposed, but without knowing the exact cause of this phenomenon and without having a clear idea of the zone of dispersion, he instinctively neglects the shot in his appreciation of the proper distance, judging it abnormal.

A gun pointer of the new school declares that the best range finder is the gun, and he only swears by the fork that must be brought astride the target. But as it is impossible to establish this fork without wasting a great number of shots, we must start with the first approximation, which is the measured distance, and alter this like the old gun pointer who always said that "all the distances they gave him were too short by 200 yards." We then observe the shots to see if there is any necessity for modification. The young gun pointer would be bolder in the amount of changes in the rear sight in order to reach the target; but beyond this advantage, "the more it changes the more it is the same thing."

There is only one method of firing at sea—universally employed: Start with an elevation deduced from the distance measured and observe the points where the projectiles fall with relation to the target. Whether we wait afterwards until we have approached to the required distance or whether we modify the elements of the pointing, we are only using different means for the application of a single principle. The better we can judge the shots the more certain is this application, and for this reason an elevated post of observation is a guarantee of precision. In the scientific setting of the rear sight we frequently risk a deception, because the elements which we can foresee are of a superior order to those of which the extended variations determine the movement of the sight. The officers who do not apply to their sights at sea the nice corrections of the observations on shore will not be long in observing this analogy. A level-headed gun pointer who has had occasion to pursue the difficult study of personal initiative some years ago will have acquired the advantage of managing the fire of his pieces without allowing himself to be troubled by disquieting deviations. He will have in his auxiliaries, pointers, and range finders all the confidence they merit, and as this is a communicative virtue he will not be exposed to having his directions suspected and his orders changed.

We do not wish to close without mentioning the happy influence of the lieutenant who founded the course for the officer pupils on the schoolship. One is only betrayed by one's friends; and those of his pupils who have done the most damage to the new studies by a fanaticism as regrettable as it is excusable in assuming that they have reestablished gunnery practice have not been able to free themselves from the old prejudices. They have given proof of this in showing their disappointment at the result of the target practices which they have conducted. Had they already forgotten his lessons?

It is our desire that these few lines will build up the faith of all those who have not been able to arrive at a common understanding and that finally discord may cease.

VI.

TARGET PRACTICE IN THE ENGLISH NAVY.

Translated from Le Yacht.

By a curious coincidence, while the French Mediterranean squadron was engaged in the target practice which sunk the floating battery *Arrogante* in presence of the minister, the English cruiser *Arrogant* carried out an experimental practice for the minister of war against the following target:—a 9.2 inch gun with a steel shield of 2.95 inches placed at an altitude of 170.6 feet. The gun's crew was represented by manikins, and a screen was placed behind the piece to prevent its being outlined against the sky. All objects were painted gray, and the dimensions of the group were 19.7 by 4.9 feet.

They fired from a distance of 2,187 yards, doubtless exactly marked by buoys, with shells charged with black powder, and while steaming at a speed of 12 knots.

The results of the practice were as follows:

They steamed past the target four times, firing during six minutes each time, twice for the 3 inch guns and twice for the 6 inch, both rapid fire. The 3 inch guns fired 253 shots with 5 guns and made 138 hits. During one passage all the crew of the piece were declared killed except one manikin. The three 6 inch guns, while passing the target twice, fired 73 shots and made 54 hits. Note that by "hits" we do not mean bull's-eyes, but the marks produced by the bursting of the shells, which is quite different. The efficiency of the practice is nevertheless very satisfactory considering the number of shots fired, although the rapidity of fire may be considered but middling, since it reached only 2 shots per minute for the 6 inch and only 4 shots for the 3 inch, though the latter can fire 17. They also counted on the target 331 hits from the Maxim guns, without giving the number of shots fired.

This practice is considered the more satisfactory since the *Arrogant* has only been in commission for six months.

This question being more than ever to the front since the Hispano-American war, it is interesting to review the criticisms of a gunnery officer of the English Mediterranean squadron.

It is first necessary to have a correct idea of the kind of target employed, which is always fixed. It consists of a raft of 41 feet long, on which are erected three masts supporting a canvas screen 15.7 feet high by 19.7 feet long, at each end of which is a triangular screen 17.7 feet on the base, and hauled out to a spar rigged like a bowsprit at each end of the raft. The vessels engaged in target practice steam along a measured base marked by three buoys, of which the center one is 1,399 yards from the target and the end buoys 1,596 yards from the center one. The speed is 8 knots, and the time of passing the buoys is six minutes, and the vessels are only allowed to fire while within the buoys. For certain vessels whose turret guns are slower fire they make use of a longer base, but always passing at the same minimum distance from the target. For the large calibers the vessels steam past the target twice. For the medium-caliber rapid-fire guns the target is the central screen (19.7 by 15.7 feet) without the triangular wings. In the latter case the speed is 12 knots, and each gun fires two volleys of one minute each, the first volley by the first gun captain and the second by the second.

The following are the results obtained in 1897 by the English Mediterranean squadron, comprising 11 battleships, 1 coast-guard battleship, and 8 cruisers:

Calibers.	Shots fired.	Hits.	Percentage.
13.4 inch	174	35	20
9.8 inch	30	17	43.5
9 inch	46	10	21.7
6 inch	13	0	0
5 inch	66	15	22.7
6 inch R. F	665	141	23
4.7 inch R. F	482	141	27.2

It should be stated that the percentage varies a great deal among the vessels. For example, with the 13.4 inch guns one battleship—the *Nile*—fired 23 shots in 12 minutes and made 12 hits, or 52 per cent, while another vessel fired 22 with only 1 hit, and a third only fired 14, or 3½ shots per minute, without any hits.

The *Nile* must have fired, therefore, according to these figures, nearly two shots per minute with four guns, or for each gun an interval of only two minutes between successive shots, which we consider a very remarkable rapidity of fire, and which we wish to see realized by similar calibers in the French navy. It is clear that the most important point in gunnery is to hit the mark; but it should not be forgotten that that is only a factor of efficiency, and we are inclined to believe that the second factor—that is to say, the rapidity of fire—leaves, or at least has left, a great deal to be desired as far as concerns the large calibers, by reason of the slow movement of the hydraulic apparatus. Progress has been made, we know, in this respect; but is it sufficient?

Concerning the rapid-fire guns, we can not but approve the English method, which consists of firing during one minute. It is the only means of finding out the service we may expect from such guns, and from the efficiency of the gun pointers, to whom this exercise is very profitable. The best target practice of this kind in the English navy gave for the 6 inch guns 33 per cent, at a rapidity of 3.7 shots per gun per minute.

For the 4.7 inch guns, the rapidity was 6.7 per gun per minute, with 50 per cent of hits. Alongside of these results, which are in every way remarkable, other vessels had middling, and even very bad, practice, which brought down the averages of these calibers to 23 per cent and 29.2 per cent. We should note in passing that the 6 inch gun is not very handy to load and point as a rapid-fire gun, which explains the superior result of the 4.7 inch, though contrary to the rule generally admitted, but which is not confirmed by the above table, that the large calibers are more accurate than the small.

The Admiralty has just published the results of competitive target practice up to June 30, 1898, for the entire navy. They are much the same as those of the above table, with slight progress. They cite, however, a battleship of which certain calibers from 16 inch to 6 inch made no hits, while eight other vessels with rapid-fire guns of from 4 inch to 6 inch only made something less than 10 per cent.

The China Squadron, according to the figures given, is ahead of all the others in target practice, but that result perhaps is due to the fact that, on that station, instead of using the ordinary targets, they usually make use of certain small rocky islands, and that perhaps the part marked out on the rocks is larger than a regular target.

The estimation of the effectiveness of the gun fire of vessels is, moreover, subject to many errors when it is made from on board. Very often a shot falling short throws up a jet of water which hides the target, and is counted as 19.5, when the maximum is 20, though in actual firing against a ship the shell would only reach her hull after the ricochet—that is to say, under very unfavorable conditions. This error is particularly frequent with targets of small dimensions, such as the spheres of 3 inches diameter (three superimposed) used in our Navy. Besides the large target described above, and which is used for prize firing, the English also use small targets, called service targets, which are triangular, with 9.8 feet at the base and 4.9 feet high.

We give our preference, without hesitation, to the large targets, whether they are fixed or towed, like those used for target practice for coast batteries.

In firing thus at a surface large enough to represent a considerable portion of the side of a vessel, we may throw out all shots which do not hit the target. You count the holes made by the shots at the end of the practice, and thus avoid the dangers of deceiving yourself by making a too favorable estimation, or even an imaginary one, and which it is impossible to check. For, excepting the very small number of shots which strike the sphere or cut it down, the estimation must be made of projectiles which leave no trace, unless from a point at one side of the line of fire you notice whether they are short or over. Target practice against a rock, of which a certain part of the surface has been whitewashed, also appears preferable to that against the spheres, because it permits the fire to be regulated under more normal conditions, and gives a good idea of the real effective power of the ship's battery.

The employment of targets of large dimensions does not exclude the use of small towing targets, but these could be reserved for subcaliber practice, which it is very useful to multiply as much as possible, with relatively high speeds. The large target has only one inconvenience, which is that it is clumsy and sometimes difficult to handle at sea; but target practice, particularly with the large calibers, has given rise to more serious complaints. Certain English commanders, it appears, and particularly the executive officers, object to the damage to the paint work and the tarnishing of the bright work, from the mastheads to the orlop deck, with an impalpable powder which soils everything. The big guns break glass, bulkheads, etc.

Let it suffice as a conclusion to this study, to have called the attention of our readers to the advantages of adopting, as our neighbors have done, the large floating target, fixed or moving, or even established on shore, to the exclusion of the sphere target, and the substitution for the notation from 15 to 20, which never expresses the reality, of the more practical one of marking the shots as hits or misses, for it is to this simple formula that gun fire is reduced.

VII.

NOTES ON BOILERS AND TURBINES.

By Lieut. Sumner E. W. Kittelle, United States Navy,

Staff Intelligence Officer.

WATER-TUBE BOILERS.

The use of water-tube boilers in war ships continues to spread among the more powerful navies and to extend from them to the lesser ones. Some countries have held back, uncertain of the value of water-tube as compared with cylindrical boilers; others, convinced of the superiority of the former, have considered only the question of the best water-tube boiler for a given type of ship.

Exhaustive trials have taken place at many naval centers with a view to determining the best among a large number of the leading types, and, other things being equal, the leading powers naturally prefer to patronize home industry; but in some cases the trials have been held on broad and generous lines, seeking to obtain the best boiler irrespective of the land of its birth.

On one point, however, nearly all are of one mind—that at the present time, pending further discoveries, the water-tube boiler is necessary to naval efficiency afloat, and no country wishing to keep abreast with the times can afford to neglect to provide its new ships with a satisfactory water-tube boiler, and to replace by them the worn-out cylindrical boilers in old vessels.

The advantages and disadvantages of the water-tube as compared with the cylindrical boiler have been thoroughly thrashed out in several years of controversy and are well known to the naval profession; but the adoption of the water-tube boiler does not rest upon strong argument so much as upon the results of its trials in service abroad and the lessons learned of its tactical value.

Boilers with large tubes are being installed in large vessels and boilers with small tubes in torpedo boats, but the line between large and small tubes is almost as difficult to draw as that between "rapid-firing" and "breech-loading" guns. Some of the small-tube boilers have had larger tubes fitted and vice versa. In every case water-tube boilers must have a sure and easy feed, owing to the small amount of water carried.

In selecting a type of water-tube boiler the weight, space occupied, economy, and durability are the principal points considered, and when the choice is once made care in manufacture and good management in service will result in efficiency. The rapidity with which steam can be raised in water-tube boilers and the facility with which they meet sudden demands for increased power make them of immense tactical value in war time, it being possible in many boilers to obtain full steam pressure in a little over half an hour after lighting fires.

Experience in England has shown that boiler tubes sufficiently strong to stand all service must be of drawn steel and not over twenty diameters in length.

Although the leading types of water-tube boilers have been described in previous annual publications of this office, still at this time when certain types are undergoing searching trials abroad, a brief reference to their evaporative features will be useful. Such reference is found in a paper read before the British Association, extracts of which are given below:

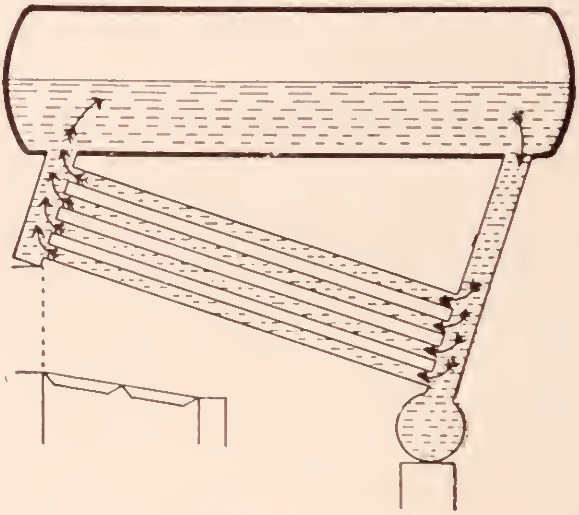


FIG. 1.—BABCOCK-WILCOX.

The Babcock and Wilcox boiler, which has been used for land installations to a great extent, but less so for marine work, consists of a large steam and water drum, running from back to front. At each end is an arrangement admitting of the connection of a number of large and nearly vertical tubes of square section and peculiar form. These are called "headers," and each pair, back and front, is connected by a number of slightly inclined straight tubes, arranged vertically over each other. At the front end all these tubes are expanded into holes in the front headers; at the back end into the back header. Small access doors, or covers, are provided in the headers opposite to the horizontal tubes. The fire is under the tubes. The water circulates by descending from the back end of the drum down the back headers. It passes from these by the inclined tubes (slightly rising) to the front headers; up these into the drum. The latter is exposed to the hot gases beneath, but only after they have parted with most of their heat. It will be observed that the tubes are firmly fixed at both ends, and that if some of the tubes—say the lower ones—expand more than others, there must be deformation somewhere. Under ordinary temperatures the success of the boiler is, however, undoubted. The tubes discharge the steam and water below the water level in the drum. They are "drowned" tubes.

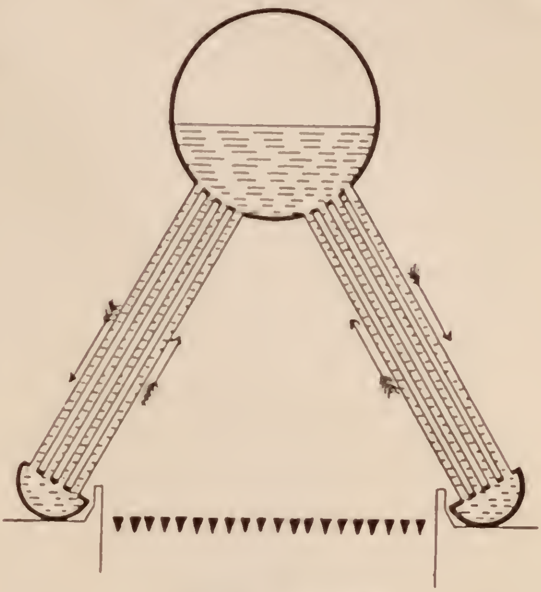


FIG. 2.- YARROW.

Another boiler which works with "drowned" tubes is the Yarrow boiler, the success of which in small war vessels, and it is now claimed in large ones also, has been very marked. The drum runs from back to front, as in the Babcock boiler, and the tubes, which are straight and of small diameter, are expanded directly into it in two groups, one on each side, so that the boiler with its tubes forms an inverted V. All the tubes of each group are expanded at the lower ends into a flat-sided horizontal drum just below the fire level. The fire is between the two bottom drums. In this boiler, as in the Babcock, the tubes are held fast at each end, but there is obviously a greater elasticity of structure, and the boiler is stated to be capable of extreme forcing without any trouble arising from unequal expansion. The circulation is from the upper drum downward, either by special large "down-comer" pipes, or by the outer and less heated tubes of each group, and up again by the small tubes or those of them which are nearest the fire. It will be noticed that the steam is delivered into the drum very equally throughout its length.

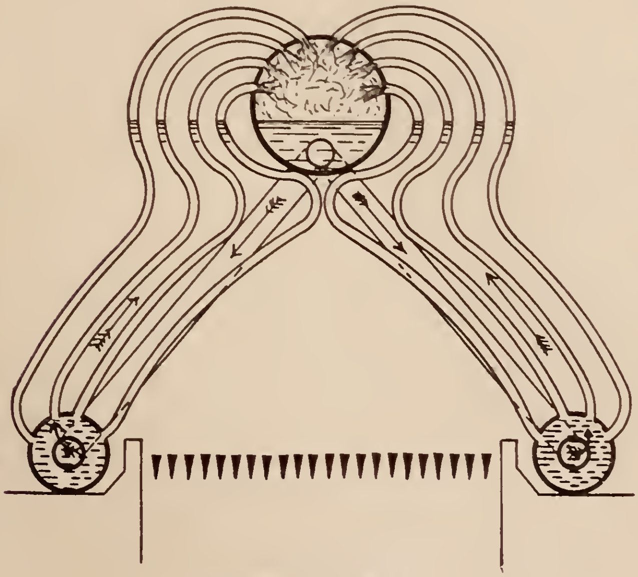


FIG. 3.- THORNYCROFT.

The well-known Thornycroft boiler has a somewhat similar arrangement of upper and lower drums, but the tubes are curved, thus adding materially to their length and heating surface, and making unequal expansion a matter of small importance. But an important difference is that the tubes are not "drowned." They deliver into the drum above the water line. There is thus no natural circulation through the tubes only when the water level is artificially raised in them by the conversion of part of the contained water into steam, when the contents are, of course, violently ejected, and are replaced by other water coming in from the lower drum. The steam space of the drum is thus to some extent filled with a mixture of water and steam, but there are special arrangements for separating them which are said to be effectual in securing ordinarily dry steam. The name "foaming boiler" has been applied to this class of generator, not in any sense of disparagement or to suggest that they do not or can not give dry steam, but to distinguish them from boilers which return the steam to the reservoir beneath the water line, leaving it to escape from the surface of the water into the steam space in the usual way.

The last typical boiler, the much-discussed Belleville, is also of the "foaming" class. There is a transverse drum, with a number of "elements" depending from it, each consisting of a number of straight tubes of large diameter, coupled together so as to form a continuous zigzag tube from the bottom immediately over the fire to the point of delivery into the drum; the tubes which form the element reach from back to front of the boiler. Water is brought to the bottom of the zigzag by a separate downcomer from the drum. To use an electrical phrase, the tubes forming each element or group are "in series," not "in parallel;" hence the water follows a very long course in its complete circuit from the drum and back again. It can not be delivered into the drum again as water with mere steam bubbles in it, but (as from the shorter but much smaller tubes of the Thornycroft boiler) it is delivered into the steam space as foam. It will be seen that there is great elasticity in the connection of the tubes. Unequal expansion can not be of much importance.

Figs. 1 to 4 give purely diagrammatic representations of the four typical boilers described. They are not intended in any way to indicate the details of construction, but merely the course of the circulation so far as it is necessary to show it.

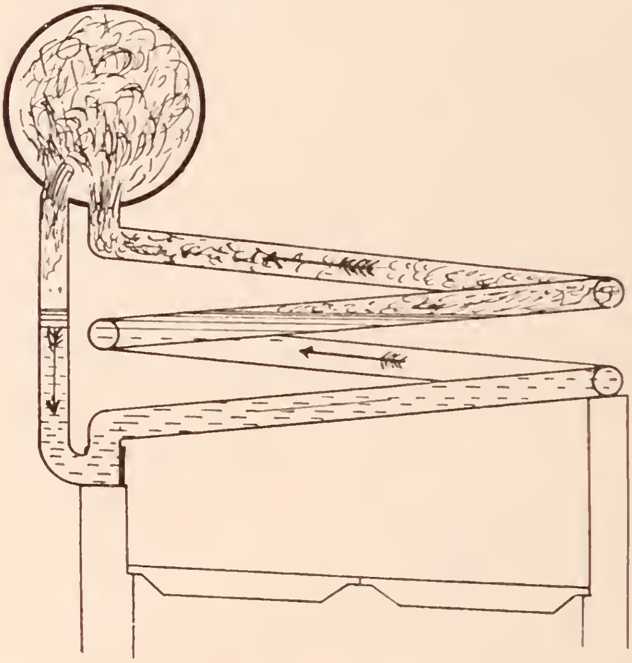


FIG. 4. – BELLVILLE.

Fig. 5 represents the circulation in the Niclausse boiler (it will approximately represent that in the Dürr boiler also). The two headers of the Babcock boiler are replaced by one divided header, providing for both the down and the up streams. The water is taken to the back end of the generating tubes by inner circulating tubes, and consequently the tubes exposed to the hot gases have the very great advantage of being fixed by one end only, and are thus entirely free to expand and contract as they please without compromising the attachment of adjoining tubes. The tubes are "in parallel," hence the water is in presence of the fire only for a short time in making each complete circuit. It gives up its steam at frequent intervals to the drum, and before it has formed in sufficient quantity in the tube to expose the latter to the danger of overheating. Since all the tubes of an "element" discharge into the upcast portion of the header, the latter may have a large proportion of steam in it, but then it is not exposed to the hot gases, or certainly not to any gases hot enough to cause injury even if the contents were steam alone. The upcast delivers under the water line as shown, so that circulation begins immediately the water commences to heat.

As regards evaporative efficiency, there is no reason why one boiler should be much better than another, for tubes can be multiplied to give any desired ratio of heating surface to fire grate, and if the combustion arrangements, the air supply, etc., are not good in any particular boiler, there is no reason why they should not be made so. As regards the Belleville boiler, where an increase in the number of tubes only adds to the length of the course traversed by an existing circulation, it is possible that an addition to the heating surface taking effect only at the upper end of the course where the water has already taken the shape of foam, if not of steam merely, may have little effect in increasing the evaporation, though it may help to dry the steam; but in all the other types an increase of heating surface—i. e., in the number of tubes—adds to the number of complete circuits in operation.

The most obvious advantage of the Niclausse boiler lies in the practical details of the tube connections. The tubes pass completely through the headers from back to front, the result being that the headers are greatly relieved from pressure upon their front and rear surfaces. So far as the area of the tube goes, the pressures are self-contained. The excellent hold obtained by passing the tube completely through the header also insures its being well supported horizontally, even if the rear end is entirely free. If the tube were merely expanded into the rear face of the header (as the diagrammatic fig. 5 suggests) the whole pressure against the inside of the rear end of the tube would be borne by the rear face of the header, already weakened by the holes cut in it for the tubes. By carrying the tube through the front as well, the front and rear faces of the header have to carry only the pressure acting upon the areas not cut away for the tubes—a very important advantage. Again, if the tube were only expanded into the rear face, the temporary or accidental removal of support from its far end would leave it supported against a great leverage only by the very short piece expanded into the thickness of the header wall, and it is difficult to believe that with this construction the tubes could long be kept tight in the header.

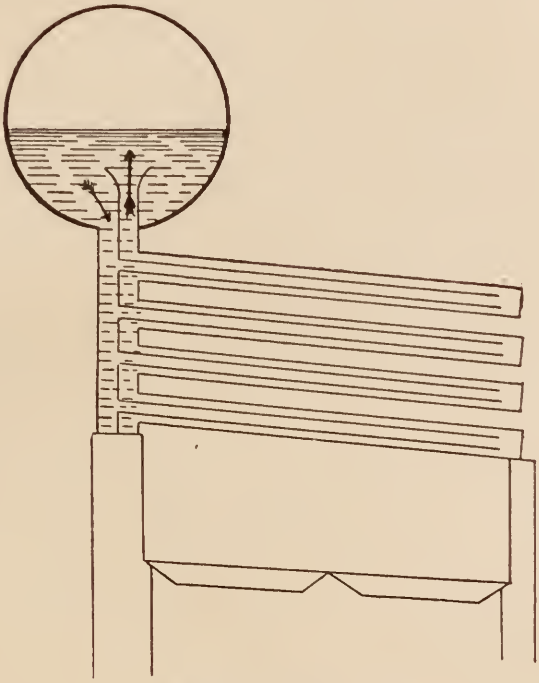


FIG. 5.—NICLAUSSE.

If the Niclausse tubes were expanded into the header, both front and back, they would no doubt have a firm attachment, but the removal of a tube would be a serious and costly matter, and it is not certain that both joints would keep tight together when different parts of the header were exposed to varying temperatures. The Niclausse tubes are not expanded in place, nor are they screwed in. They are formed with cones, which are simply pushed with very small pressure—little more than "hand-tight"—into coned holes, the front cone being a little larger than the rear one, so that the latter may pass through the hole which receives the front cone. The cones are specially shaped so as to possess a certain elasticity, which is no doubt the secret of both cones keeping tight at the same time under all conditions of temperature and pressure. The writer must confess that he took a great deal of convincing, at first, as to the permanent tightness of these double-coned joints, but the complete success of the system, after years of use, leaves no room whatever for question. It should be added that a somewhat similar joint connects each header with the drum, admitting of easy removal and replacement.

The tubes have theoretically a tendency to blow out toward the front, owing to the slightly greater area of the front hole, but the friction of the cones in their seats is enough to overcome this. To be on the safe side, however, a bar or cramp is arranged on the front of the header to hold the tube in its place under all circumstances. (*See* fig. 5, p. 169, General Information Series, XIV.) The inside of the tube is easily inspected, and to some extent can be cleaned by unscrewing the plug and withdrawing the inner tube, which, having no pressure to withstand, is formed out of light sheet metal. But it is only the work of a minute or so to withdraw the outer tube itself, and as the cones upon these are standardized, the tube can be substituted immediately, allowing the removed tube to be inspected and cleaned at leisure.

We have thus the following state of things:

(*a*) The only parts of the boiler exposed to high temperature are the tubes.

(*b*) These tubes can be withdrawn from the boiler without difficulty and without injury in a short time.

(*c*) They can be immediately replaced by other interchangeable tubes and thus a system can be instituted of withdrawing, examining, and thoroughly cleaning all the tubes in succession and at regular intervals of time. In a large vessel, with many boilers, one boiler can be laid by for a day while all its tubes are changed. On the next occasion the tubes taken out of the first boiler can be put into the next one, the tubes from the latter being similarly reserved for examination at leisure. One spare set of tubes enables all to be changed in succession.

(*d*) The examination and replacing of tubes is conducted entirely from the front of the boiler.

GREAT BRITAIN.

The First Lord of the Admiralty states that the adoption of the Belleville boiler for the battleships and first-class cruisers now under construction has been definitely decided on, and that the Admiralty are taking advantage of every suitable opportunity to test other water-tube boilers with a view to further possible improvements. Of the small-tube boilers the British use the Thornycroft most and the Normand, Yarrow, Blechynden, and others in a less degree.

Water-tube-boiler making has been undertaken in some of the navy-yards, a set of Thornycroft boilers having been built for the *Proser-*

pine at Keyham, followed by sets of Belleville boilers for the *Rosario* and *Vestal*. Keyham is to have a plant for making Normand boilers also, and Portsmouth has undertaken to build the Thornycroft boilers for the *Pandora*.

In order to prevent deterioration of boilers when vessels are laid up at navy-yards, provision has been made to store torpedo-boat boilers in storehouses ashore, where they can be carefully examined and kept at an even temperature in winter by the use of stoves.

The British engineer in chief states that "the greater weight of the Belleville boiler as compared with the small-tube type is associated with superior economy in coal consumption in ships of large bunker capacity; the excess weight in employing the heavier boiler is soon balanced by its smaller coal consumption and a much larger radius of action is obtained by its use. The rectangular form of the Belleville and similar boilers is adapted to the favorable utilization of all the available space, in which respect they are aided by their general design, the boilers being readily widened or narrowed by the addition or omission of elements in order to suit them to the space available. It appears that for small vessels of high power, where machinery weights must be reduced to the smallest limit, the small-tube type must be used, but where weight is available and the radius of action of the vessel is of relatively greater importance, the more economical and more durable large-tube boilers should be employed." For these reasons battleships, first and second class cruisers have been fitted with large-tube boilers, while third-class cruisers and torpedo boats have been fitted with one or the other of the small-tube types.

It has been found necessary in the British navy to adopt feed-water heaters with the Belleville boilers, resulting in from 12 to 15 per cent economy. These heaters, called economizers, consist of a second nest of tubes placed in the uptake above the boiler, with a combustion chamber between, into which additional jets of air are admitted to reignite the gases. The feed water passes through the economizer before entering the boiler proper. All Belleville boilers except those on the *Powerful*, *Terrible*, *Sharpshooter*, and four cruisers of the *Arrogant* class are thus fitted. The boilers with economizers have 30 per cent of the tubes omitted, there being seven instead of ten pairs of tubes to an element.

The *Seagull*, with Niclausse boilers, and the *Sheldrake*, with Babcock-Wilcox boilers, have both undergone extensive trials to test these boilers in actual service. The trials of the *Sheldrake* gave satisfactory results, except that at the end several tubes were found distorted from overheating. The following table gives the results of the first trials of the *Sheldrake* compared with those of the *Seagull* and *Sharpshooter:*

Ship and boiler.	Duration of trials, hours.	Pounds coal burned per square foot grate per hour.	Equivalent evaporation from and at 212° F.		Ratio of heating surface to grate surface.	Remarks.
			Per square foot of heating surface per hour.	Per pound of coal.		
Seagull (Niclausse boilers) ..	8	14.6	4.91	10.77	31.9	Trial on board.
	8	24.2	7.31	9.61	31.9	Do.
Sheldrake (Babcock-Wilcox boilers).	5	22.5	5.95	12.1	45.7	Trial on shore.
	8	15	5.29	12.7	36.1	Trial on board.
	8	25	7.68	11.1	36.1	Do.
Sharpshooter (Belleville boilers; no economizers).	8	21	7.85	11.05	29.6	Do.
	8	13.1	4.70	10.65	29.6	Do.
	8	9.9	3.53	10.55	29.6	Do.
Belleville boiler and economizer, average of many ships.	4	30.13	11.79	11.67	31.3	Trials on shore.

These and subsequent trials of the *Sheldrake*, as reported in The Engineer, are described below, and as the boilers used are also in use in our Navy, the results will be of special interest.

The Sheldrake is a steel twin-screw gunboat, built at Chatham Dockyard in 1889, and engined by Messrs. Maudslay, Sons & Field with two sets of triple-expansion engines of 3,500 indicated horsepower, having cylinders 22 inches, 33 inches, and 49 inches diameter, with a 21-inch piston stroke. She is 230 feet long between perpendiculars, has a beam of 27 feet, a displacement of 735 tons, and a draught of 8 feet 3 inches.

New boilers have lately been fitted in her to replace the old type naval boilers. They are of the Babcock-Wilcox water-tube type, set in pairs in two boiler compartments, divided by a water-tight bulkhead, the boilers being back to back, fired fore and aft, and each having its own stokehole. There are nineteen sections of tubes in each boiler, all of solid drawn steel, galvanized on the outside, those connecting the headers and cross boxes being $1\frac{13}{16}$ inches diameter. The uptake headers are connected to the steam and water drum by 4-inch diameter tubes; downcomer tubes, which are also 4 inches diameter, being taken from each end of this drum and connected to a wrought-iron mud box provided with blow-off and drain valves, the level of the water in the drum being regulated by a Thornycroft feed-water regulator. The total grate surface in the four boilers is 252 square feet and the heating surface 9,424 square feet.

Four 6-foot diameter double-inlet fans, driven by independent engines, and capable of running at 600 revolutions a minute, supply an increase of air pressure in the stokeholes. Each pair of boilers has an independent uptake and one funnel, the latter being 5 feet diameter, with its top 45 feet above the grate bars. For facility of firing, and to prevent too great an inflow of cool air while stoking, each boiler furnace has three fire doors, which, it will be noticed, are so hung as to swing well clear of the mouth of the furnace while being fired. The boilers are made for a working pressure of 200 pounds per square inch, reduced at the engines to 150 pounds. They were built under strict survey by Admiralty surveyors, and one of them—as per contract—was erected on shore at the makers' works, and subjected to tests by Admiralty officials to determine its capabilities and efficiency.

The makers' guaranty was that any one of the boilers steamed on shore would, with Welsh coal and feed water at 110° F., evaporate from 11,000 pounds to 12,000 pounds of water per hour with natural draft, and from 18,000 pounds to 19,000 pounds of water per hour with a forced draft, not exceeding 3 inches of water, the feed water being the same temperature, viz, 110° F. The boiler under test was fitted with a funnel 3 feet 6 inches diameter and 45 feet high above grate bars, assisted draft being obtained by a steam jet in the funnel, the results obtained showing that with only a one-fourth inch of air pressure in the ash pit for three consecutive hours' run the water evaporated per hour from a temperature of 70° was 19,577 pounds, equivalent to 20,250 pounds for 110°; the rate of combustion per square foot of fire grate was 40.7 pounds, the test showing that about 72 per cent of the heat value of the fuel could be utilized with suitable bars and draft.

Trials were subsequently made, one to ascertain the economy at a lower rate of combustion, when 73.5 per cent of the theoretical heat value of the coal was obtained; and one for the highest economy, with the grate area reduced to 54 square feet and a rate of combustion of 22.5 pounds per square foot of grate per hour, when an efficiency of 81 per cent was realized, the draft not being assisted in any way.

The first sea trial of the *Sheldrake* took place on November 28, 1898, and was of eight hours' duration, all four boilers being in use. It was a trial for economy, 15 pounds of coal being burned per square foot of grate per hour. The steam pressure at the boilers was 152.5 pounds per square inch and an air pressure of 0.2 inch of water, the temperature of the feed water being 103° and of the steam 366°. The power developed by the engines running at 242 revolutions per minute was 2,642 I. H. P.; the speed of ship attained 17.9 knots an hour, and the coal consumption 1.429 pounds per I. H. P. per hour.

On December 1, 1898, a full-power trial was made at sea, the four boilers being in use, the results attained at it being as follows: The average steam pressure maintained in the boilers was 150 pounds per square inch, the air pressure in stokeholes being equal to half an inch of water. The temperatures were, external air, 57°; in boiler room, 70°; feed water, 110°; steam, 365°. The coal—Powell-Duffryn—burned was 6,462 pounds per hour. With the engines making 280 revolutions per minute, the power developed by them was 4,050 I. H. P., the average speed of the ship being 20.6 knots per hour. The coal consumed on this trial was at the rate of 1.57 pounds per I. H. P. per hour, the heating surface being 2.3 square feet per I. H. P., and the I. H. P. per square foot of grate, 16.

The foregoing recorded trials of the *Sheldrake* took place at the latter end of 1898, and were but preliminary to an exhaustive and interesting series that has just been completed. The vessel was commissioned on the 14th of February, 1899, and since that date has gone through a series of nine 1,000-mile runs at various rates of steaming, during which the three after boilers only were used, the fourth—the forward—being held in reserve (cold).

The program of the trials to be gone through while in commission were: Four 1,000-mile runs with engines developing 1,500 horsepower, two 1,000-mile runs with engines developing 1,800 horsepower, two 1,000-mile runs with engines developing 2,000 horsepower, and one 1,000-mile run with engines developing 2,250 horsepower. The first four trials, which were commenced on February 28, March 14, April 7, and April 14, respectively, were satisfactorily completed, the economy realized averaging 1.58 pounds of coal per I. H. P. per hour, the weight of coal burned per square foot of fire grate being 12½ pounds.

The results attained on the 2,000-horsepower runs, which commenced on June 4 and July 3, respectively, were a coal consumption of 1.56 pounds per hour, the coal burned per square foot of grate being 16½ pounds.

On May 5 and June 8, respectively, the runs at 1,800 horsepower were commenced, the coal consumption during each of them being 1.6 pounds per I. H. P. per hour, and the quantity burned per square foot of grate 15¼ pounds.

On July 17 the ship left for the ninth and last of the 1,000-mile runs, when the following results were realized: Indicated horsepower developed, 2,250; coal burned per I. H. P. per hour, 1.62 pounds, a weight of 18¾ pounds of coal being burned per square foot of fire grate.

At the completion of the 1,000-mile trials some interesting experiments were made directly connected with the boilers. The first was on the forward boiler with the view of ascertaining in what time steam could be raised to 140 pounds pressure from water at 70° F.; this was found to be twenty-three minutes. This was followed by a stopping and starting test, the engines, while going at full speed, being suddenly stopped. The front, tube, and uptake doors were simultaneously opened and ashpit doors closed, when the rise in the pressure gauge did not exceed 5 pounds, neither did the safety valves lift. A test was then made to see how soon the operation of drawing a tube could be commenced after drawing fires, and how quickly a tube could be taken out of a boiler.

To determine the first, when the boiler was working at full power the fires were suddenly drawn and the water blown out. In twenty-four minutes after drawing fires several caps were taken off ready for tube drawing. Three tubes were subsequently drawn, one after the other, the first taking eleven, the second ten, and the third nine minutes.

The *Seagull*, with Niclausse boilers, began her nine trials of a thousand miles each in September, 1899, but few of the results are available yet. The trials differ from those of the *Sheldrake*, as the *Seagull* uses four out of her six boilers, while the *Sheldrake* used three out of her four boilers. Four runs are to be made at 1,350 I. H. P., two at 1,600 I. H. P., two at 1,780 I. H. P., and one at 1,900 I. H. P.

	Steam.	I. H. P.	Revolutions.	Speed.	Coal per I. H. P. per hour.
	Pounds.			*Knots.*	*Pounds.*
First run	120	1,354	187	13.2	2
Second run	....	....	....	....	....
Third run	....	1,369	....	12.9	2.1
Fourth run	....	1,350	....	13.2	....

The life of tubes in Belleville boilers is reported to be about six years in the British service, and it is possible when the present Belleville boilers wear out that they will be replaced by another make. The life of the small tube boilers is shorter, due to forcing and to the fact that the tubes are thinner and more difficult to clean. An order has been issued requiring the use of distilled water in all water-tube boilers in order to avoid in a greater degree the corrosive effect of the gases and salts in fresh water obtained ashore. Of course no one will allow salt feed if fresh water can be obtained, but there seems to be no cause for alarm if salt feed must occasionally be used, as the tubes of water-tube boilers are no more likely to suffer from scale than the furnaces of cylindrical boilers.

A number of cases of bursting tubes have been reported, in most cases due to the tubes being obstructed by dirt. Where a pressure of 300 pounds is carried in boilers in British ships this pressure is reduced to 250 pounds at the engine, which seems to be an unnecessary loss of efficiency.

Mr. A. F. Yarrow has carried on some experiments with a view to ascertaining the comparative merits of nickel steel tubes and those of mild steel for water-tube boilers.

The nickel steel to which Mr. Yarrow refers is an alloy, having from 20 to 25 per cent of nickel, and in these experiments he has tried to repeat, as nearly as possible, the worst conditions as regards wear and tear to which tubes in water-tube boilers are subjected.

The deterioration of the tubes is probably owing—

(1) To the action of acids in the water, due to grease, which, in spite of every precaution, finds its way into the boiler.

(2) To the tubes becoming overheated and oxidizing on the outside, through contact with the hot gases when passing from the furnace to the uptake.

(3) To the action of the steam, which, if superheated, decomposes, causing deterioration on the inside of the tubes.

The last two conditions occur when the tubes, from defective circulation, shortness of water, or from the collection of scale, become overheated.

Table I records what he has termed the "corrosion test." It will be seen that the piece of nickel steel tube A was compared with the piece of mild steel tube B, the original weights of which were 190 and 186 grams, respectively. Both the tubes were immersed in the same dilute solution of hydrochloric acid for various periods, as indicated. The duration of the tests varied, as shown, from twenty-one to one hundred and sixty-eight hours, making a total number of hours for all the trials of five hundred and thirty-three. The ultimate loss of weight in the nickel steel tube was 5 grams, and in the mild steel tube 98 grams. It will be seen that the original weights of the two specimens in this case did not accurately agree, but in the second trial, E and F, the tubes were of the same original weight, namely, 188 grams each. The ultimate loss of weight was found to be 7 grams with the nickel steel tube E, and 100 grams with the mild steel tube F.

TABLE I.—CORROSION TEST.

Experiments to ascertain the effects of acid on nickel steel and mild steel tubes.

Marks and material.		Original weight in grams.	Two parts water; one part hydrochloric acid.									Total loss in weight during 533 hours.
			Duration of immersion in hours.									
			21	64	44	92	168	72	24	24	24	
			Weights in grams.									
Nickel steel	A. N. S.	190	190	189	189	188	186	186	185	185	185	5
Mild steel	B. S.	186	184	173	166	140	101	98	94	91	88	98
Nickel steel	E. N. S.	188	188	187	187	186	183	182	181	181	181	7
Mild steel	F. S.	188	187	173	162	137	112	95	92	90	88	100

The upshot of the above tests, it will be seen, is that the loss of weight in the first series of tests of the nickel steel tube amounted to 5 grams, being 2.63 per cent, and in the mild steel tube to 98 grams, being 52.68 per cent. In the second series of experiments the loss of weight of the nickel steel tube was 7 grams, being 3.72 per cent, and the mild steel tube 100 grams, being 53.19 per cent. The average loss of weight in the mild steel tube was therefore 16½ times what it was in the nickel steel tube.

The tubes as they appeared on the termination of this experiment are shown on Plate I.

It may be contended that the relative corrosion of the two specimens when using dilute hydrochloric acid does not correspond with what it would be with such acids as are present in boilers under working conditions, but it is not unreasonable to suppose that it may serve as a guide.

Table II.—Fire test.

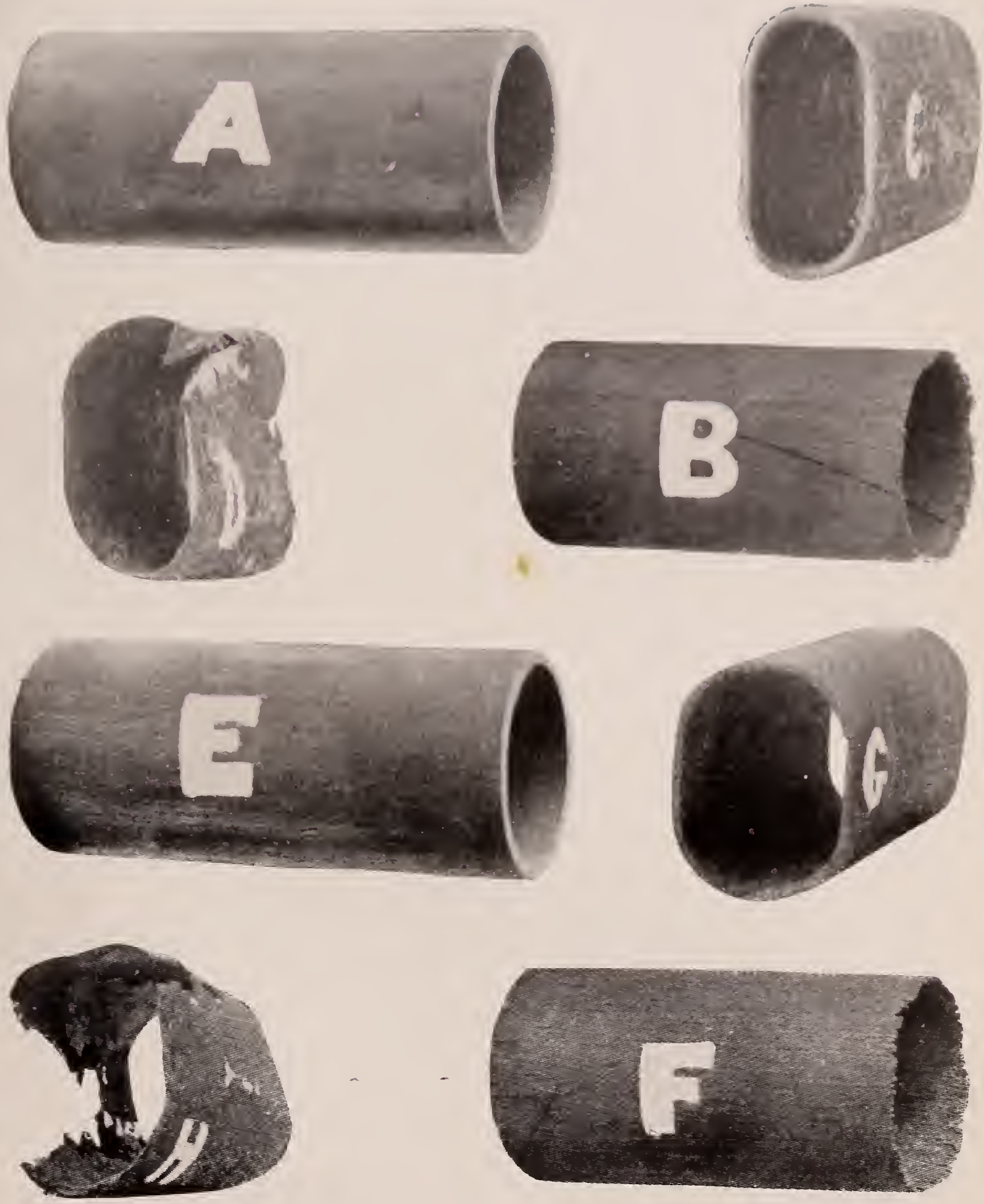
Experiments to ascertain the effects of fire on nickel steel and mild steel tubes.

Marks and material.		Original weight in grams.	Heated blood red for thirty minutes and allowed to cool.	Heated bright red and cooled in water.	Scale removed.	Heated straw colour for one hour and allowed to cool.	Tubes partly flattened to remove scale.	Heated straw colour for one hour, and allowed to cool. Scale removed.	Heated straw colour for one hour, and allowed to cool. Scale removed.	Heated straw colour for one hour, and allowed to cool.	Scale removed.	Total loss in weight in grams.
			Weights in Grams.									
Nickel steel	C. N. S.	192	192	190	190	171	170	159	151	145	145	47
Mild steel	D. S.	185	184	183	180	130	120	94	68	42	40	145
Nickel steel	G. N. S.	188	188	186	186	172	172	153	142	139	136	52
Mild steel	H. S.	188	188	186	184	147	145	89	58	51	45	143

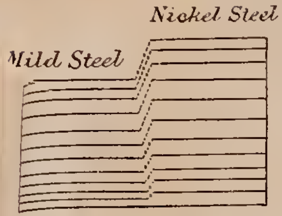
Table II shows what he has termed the "Fire test." This was conducted in the following way: Two tubes were placed side by side in a small brick furnace, where they were heated to the same extent, and in every way were practically under the same conditions. The loss of weight of each tube due to oxidation after they had been in a very heated state is indicated by the weights given. It will be seen that the original weight of the nickel steel tube C was 192 grams, and the mild steel tube D was 185 grams. The total loss of weight in this series of tests was, in the case of the nickel steel tube, 47 grams, or 24.47 per cent, and of the mild steel tube, 145 grams, or 78.37 per cent. In this case also the original weights of the two pieces of tube were not exactly the same, and we therefore repeated the experiment, as shown by G and H, in which the weights of the two tubes were identical, namely, 188 grams, and the loss of weight was found in the nickel steel tube to be 52 grams, or 27.66 per cent, and of the mild steel tube 143 grams, or 76.06 per cent. The average loss in weight in the mild steel tube was therefore 2.9 times what it was in the nickel steel tube.

These tubes as they appeared on the termination of this experiment are shown on Plate I.

These results were submitted to Sir John Durston, and he pointed out that the experiments did not accurately conform to all the conditions under which boilers are worked, inasmuch as the tubes, in the case of a boiler when the heating surfaces are not in close contact with the water inside, are subject not only to the action of



YARROW'S EXPERIMENTS WITH BOILER TUBES.



EXPERIMENTS TO ASCERTAIN THE
RELATIVE EXPANSION OF NICKEL STEEL AND MILD STEEL TUBES.

Sample tubes 22 in. long, 1 in. diameter, No. 16 L.S.G.
Heated to a dull Red for about three-fifths of their lengths.

Weight of Nickel Steel Tube, 492 Grammes.
Weight of Mild Steel Tube, 492 Grammes.

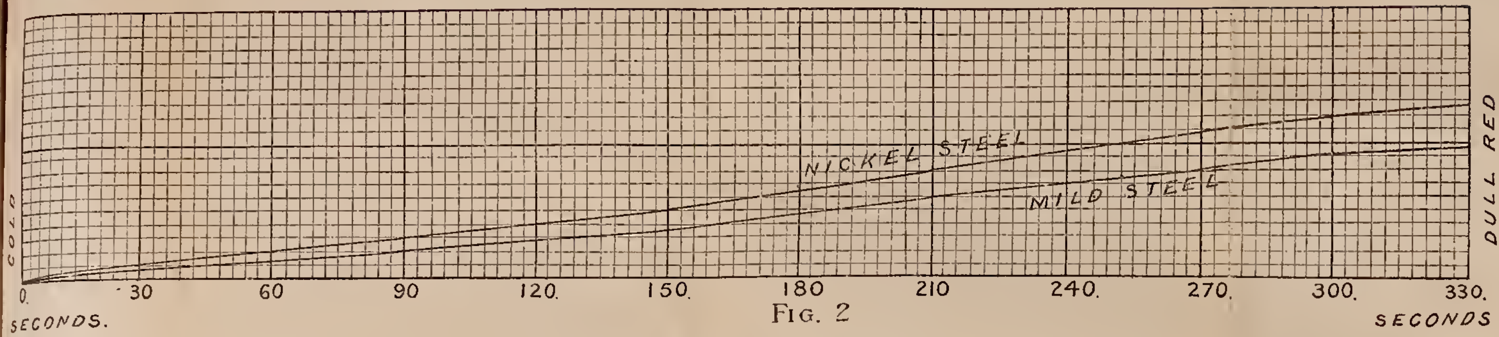


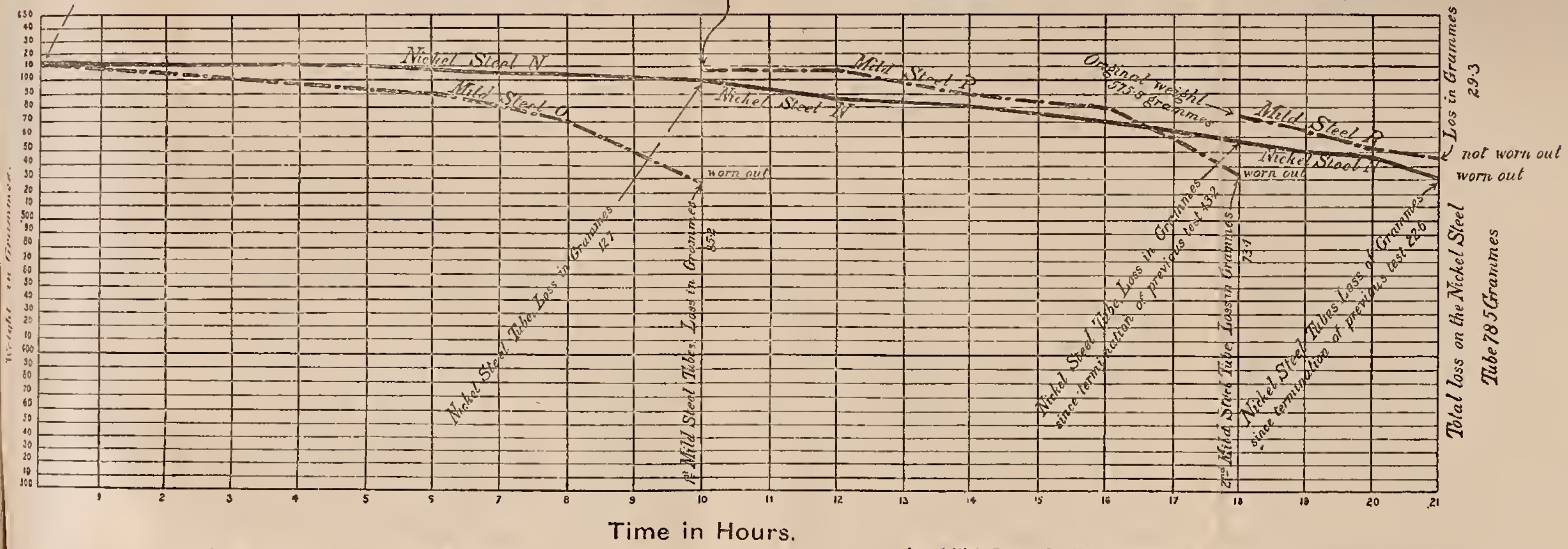
FIG. 2

SUPERHEATED STEAM TEST.

Tubes heated to a Bright Red.

Original Weight of both Specimens, 612·2 Grammes.
Original Weight, 607 Grammes.

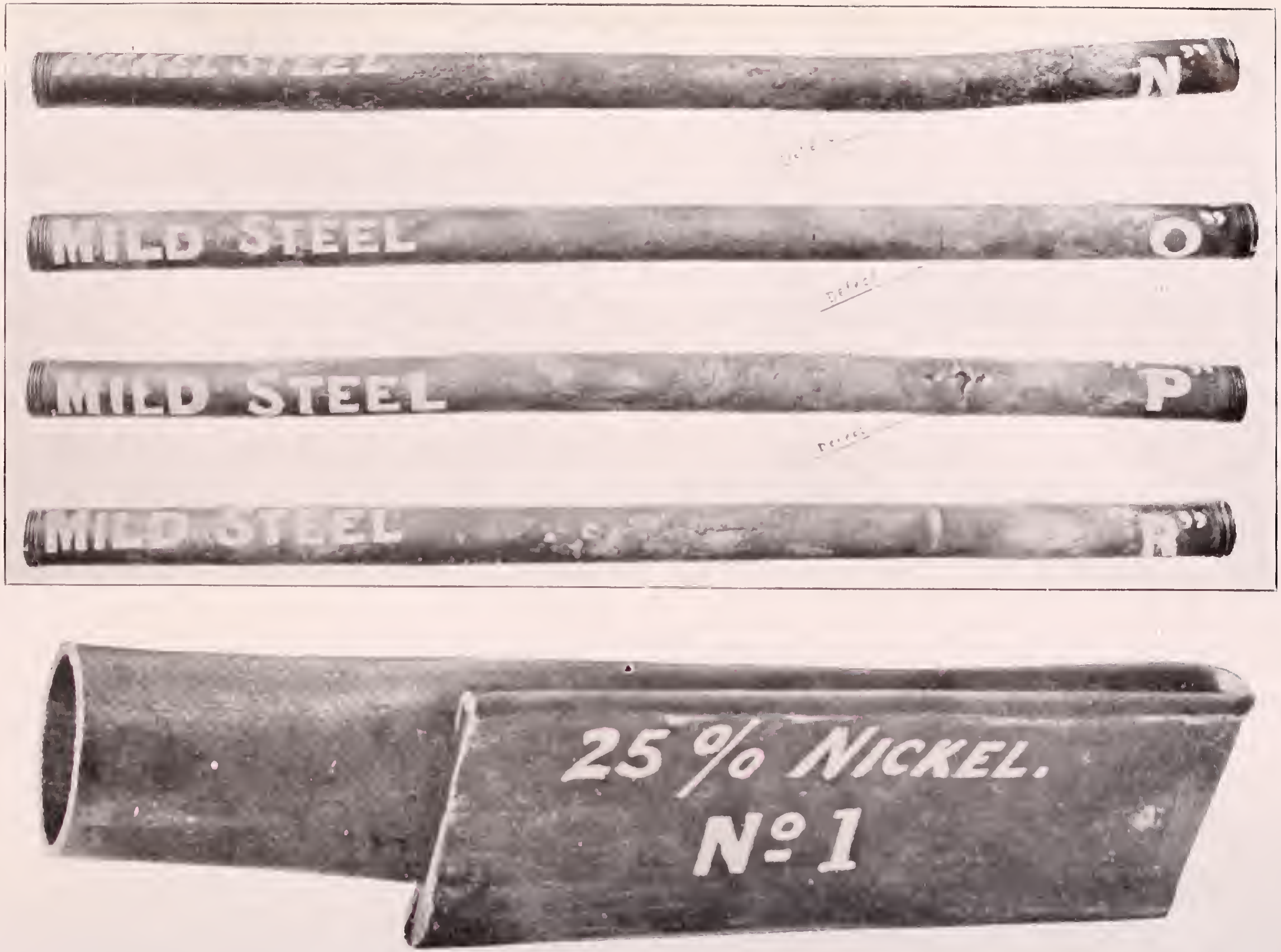
Nickel Steel Tube 1′ 8⅝″ long, 1″ outside dia., 14 L.S.G.
Mild Steel Tube 1′ 8⅝″ long, 1″ outside dia., 14 L.S.G.



Nickel Steel Tube N lasted 21 hours.

FIG 1

1st Mild Steel Tube O lasted 10 hours }
2nd Mild Steel Tube P lasted 8 hours } Mean 9 hours.



YARROW'S EXPERIMENTS WITH BOILER TUBES.

the gases on the outside, but to that of the superheated steam on the inside. The correctness of this view is unquestionable, and we consequently tested two tubes having a length of 1 foot 8⅝ inches, by a diameter of 1 inch outside No 14 L. S. G. This experiment we termed the "superheated steam test," and reference must be had to Plate II, fig. 1. The experiment was carried out in the following manner: Two tubes, one of nickel steel, N, and the other of mild steel, O, were placed side by side in a small brick furnace; at one end of each tube steam was supplied at 60 pounds. pressure, it being allowed to issue slowly from the opposite end of each tube, thus insuring the steam being highly superheated. The result of this experiment is shown on the diagram. The original weight of each tube was 612 grams. After the experiment had proceeded ten hours, it was stopped, as the mild steel tube O gave out, steam issuing from the defective place. The loss of weight in the case of the nickel steel tube N was 12.7 grams, and in that of the mild steel tube O, 85.2 grams. Deterioration in this case is due partly to the action of the steam inside the tube and partly to that of the gases outside.

The loss of weight of a boiler tube from deterioration at the commencement of its life being much less rapid than toward the end of its life, therefore the loss of weight can not be considered as a quantitative guide for durability, and we continued the superheated steam test as follows: After the mild steel tube O had burned through and allowed the steam to escape, he replaced it by another similar mild steel tube P, corresponding to what would be done in re-tubing a boiler. The experiment was then continued, and it was found this second mild steel tube gave way and the steam burst through after eight hours, the nickel steel tube still remaining intact. He then substituted another tube R for this burned mild steel tube, and found that after three hours the nickel steel tube gave out.

Every two hours during these experiments the position of the tubes was changed about, not only end for end but side for side, so as to insure both tubes being subjected to the same conditions.

The tubes as they appeared at the termination of this experiment are shown on Plate III.

It will be seen from this that the durability of the nickel steel tube corresponded to twenty-one hours, and the mean durability of the first two mild steel tubes to nine hours, therefore, there is a reasonable probability that from this cause of deterioration a boiler would require to be re-tubed 2⅓ times as often with mild steel tubes as it would with nickel steel tubes.

In the foregoing experiments the tubes were ungalvanized. Had the mild steel tubes been galvanized there would have been a small addition to their durability, the extent of which is a matter of doubt.

He then made some trials with a view to ascertaining the relative expansion by heat of the two materials. Two tubes were taken, 22 inches long, 1 inch in diameter, No. 16 L. S. G. They were inserted in a large tube and heated gradually up to a dull red for about three-fifths of their length. The tubes were fastened together at one end and projected freely and independently beyond the furnace at the other. A record of the expansion of each of the tubes was made by means of a trammel and their expansion accurately determined. It was found that the expansion of the nickel-steel tube was considerably greater than that of the mild-steel tube. Plate II, fig. 2, shows the gradual increase of length during the process of heating up, which occupied 330 seconds, and it was found that the relative expansion was approximately as 3 to 4, the nickel steel expanding the most. The object of this experiment was to ascertain whether there was sufficient difference in the expansion and contraction of the two materials to cause trouble when nickel-steel tubes are placed within a group of tubes of mild steel. The result points to possible risk in this direction, and should it be desired to place nickel-steel tubes in those parts of the boiler where deterioration proceeds with the greatest rapidity and mild-steel tubes elsewhere, this variation of expansion should be borne in mind.

The tubes corresponding to Tables I and II were not of quite the same length, the nickel-steel tubes being in all cases somewhat longer than the mild-steel tubes, and therefore, so far as this difference in size is concerned it was unfavorable to the nickel-steel tubes, which exposed a larger surface to deterioration.

To illustrate the suitability of nickel steel from a mechanical point of view see Plate IV, also No. 1, Plate III. Nos. 1 to 6 illustrate its ductility, which is almost equal to that obtainable with mild steel. The ductility of these samples is amply sufficient for all practical purposes. Nickel steel is considerably tougher in working than mild steel; it involves more labor and causes greater wear and tear of the tools employed in expanding and bell-mouthing, to which latter operation we have always attached the highest importance. The ductility does not seem to be impaired by sudden changes of temperature, as shown by specimens Nos. 7 and 8, these specimens having been bent after being heated and chilled.

It is not known what the probable ultimate price of nickel-steel tubes will be, but, doubtless, it will be reduced from what it now is if tubes of this alloy are introduced. Even at the present stage, judging from the experiments described, it is not unreasonable to expect that the longer life of the nickel steel will prove fully proportionate to its higher price, if the cost of the more frequent replacing of the mild-steel tubes is taken into account; and if this surmise be correct, clearly a decided gain would be obtained by the greater trustworthiness of boilers with nickel-steel tubes and by avoiding the frequent loss of time involved in retubing operations, during which period the boiler is laid up.

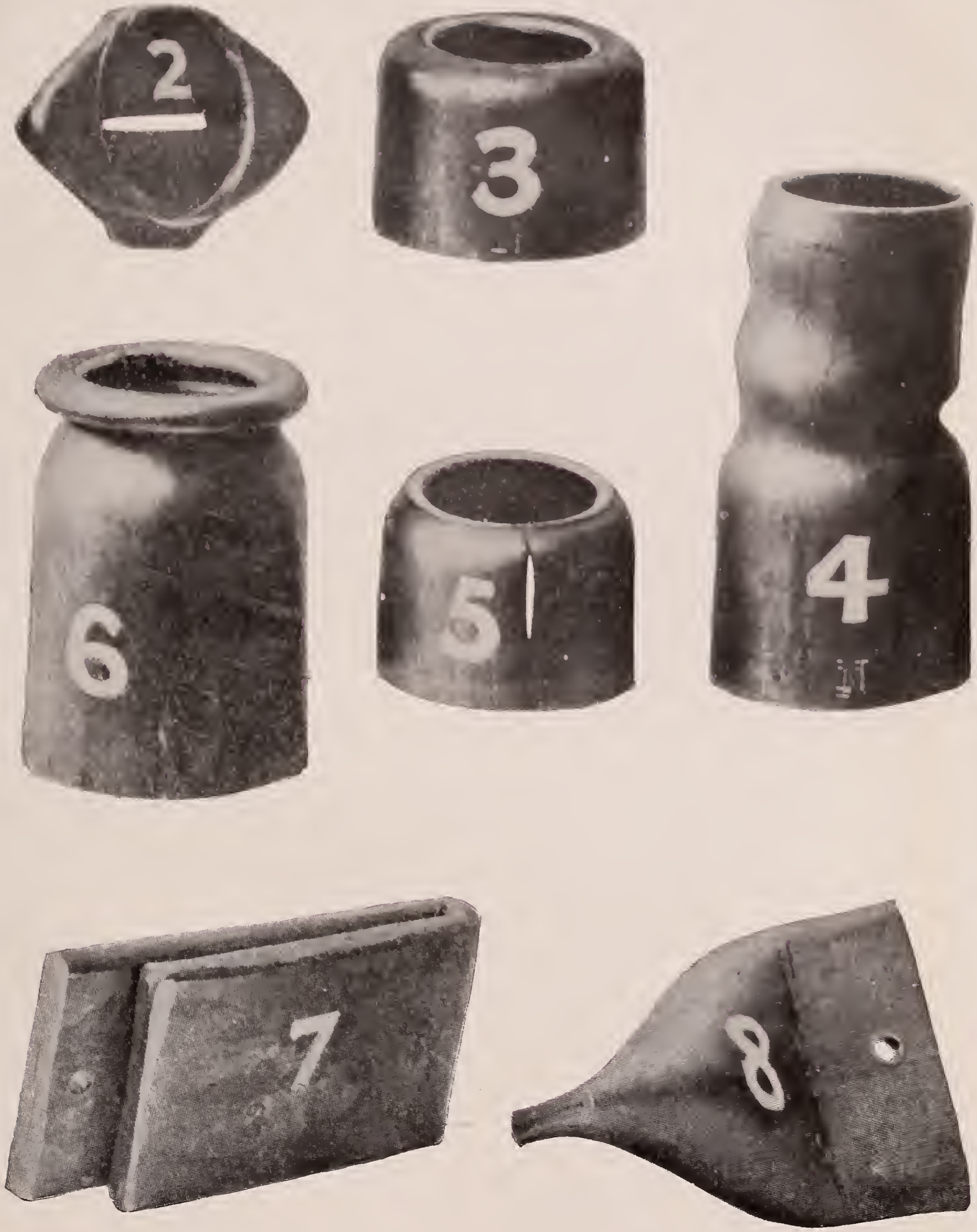
Experiments have been made as to the comparative durability of nickel steel having small percentages of nickel, up to 5 per cent, and it has been found that a very slight increase of durability is obtained by such alloys, but not sufficient to render them of any practical value for boiler tubes.

From the foregoing experiments it is not unreasonable to assume that nickel-steel (20 to 25 per cent nickel) boiler tubes will have, as regards acid corrosion, a vastly longer life than those of mild steel, and as regards deterioration from the action of heated gases or steam, at least twice the durability of mild steel.

FRANCE.

In the French service all sorts of boilers are in use, but for large vessels the Niclausse and Belleville prevail. Niclausse boilers have been ordered for the armored cruisers *Condé* and *La Gloire* and Belleville boilers for the *Devastation*, *Iena*, *Desaix*, and *Dupetit Thouars*.

The trials of the torpedo boat *Téméraire* with Niclausse boilers are very interesting. The *Téméraire* was put through severe tests with her two locomotive boilers in 1889, and obtained a speed of a little over 20 knots on 1,400 H. P., burning 82 pounds per square foot of grate. The two locomotive boilers have been replaced by two Niclausse water-tube boilers, and there is a smoke pipe for each. The total grate surface is 73.6 square feet and the heating surface 3,236 square feet. Each generator consists of twelve elements, each having forty-eight tubes 1.58 inches in diameter. The tubes are of soft steel and the inner tubes are 0.8 inch in diameter. The steam receivers are 27.6 inches in diameter, and the boiler plant is 2 tons lighter than the old one and the grate surface has been increased by 21.5



YARROW'S EXPERIMENTS WITH BOILER TUBES.

square feet. The four trials were carried out with 41, 51, 66, and 82 pounds of coal consumed per square foot of grate per hour.

	Number of trial.			
	1	2	3	4
Duration........hours..	2	2	3¼	3
Temperature of feed water........degrees..	71	71	69	66
Air pressure........inches..	.25	.40	.70	1.1
Water evaporated per pound of coal........pounds..	9.4	9.1	8.9	8.5
Water evaporated per square foot of heating surface........do....	8.6	10.4	13.5	16.2

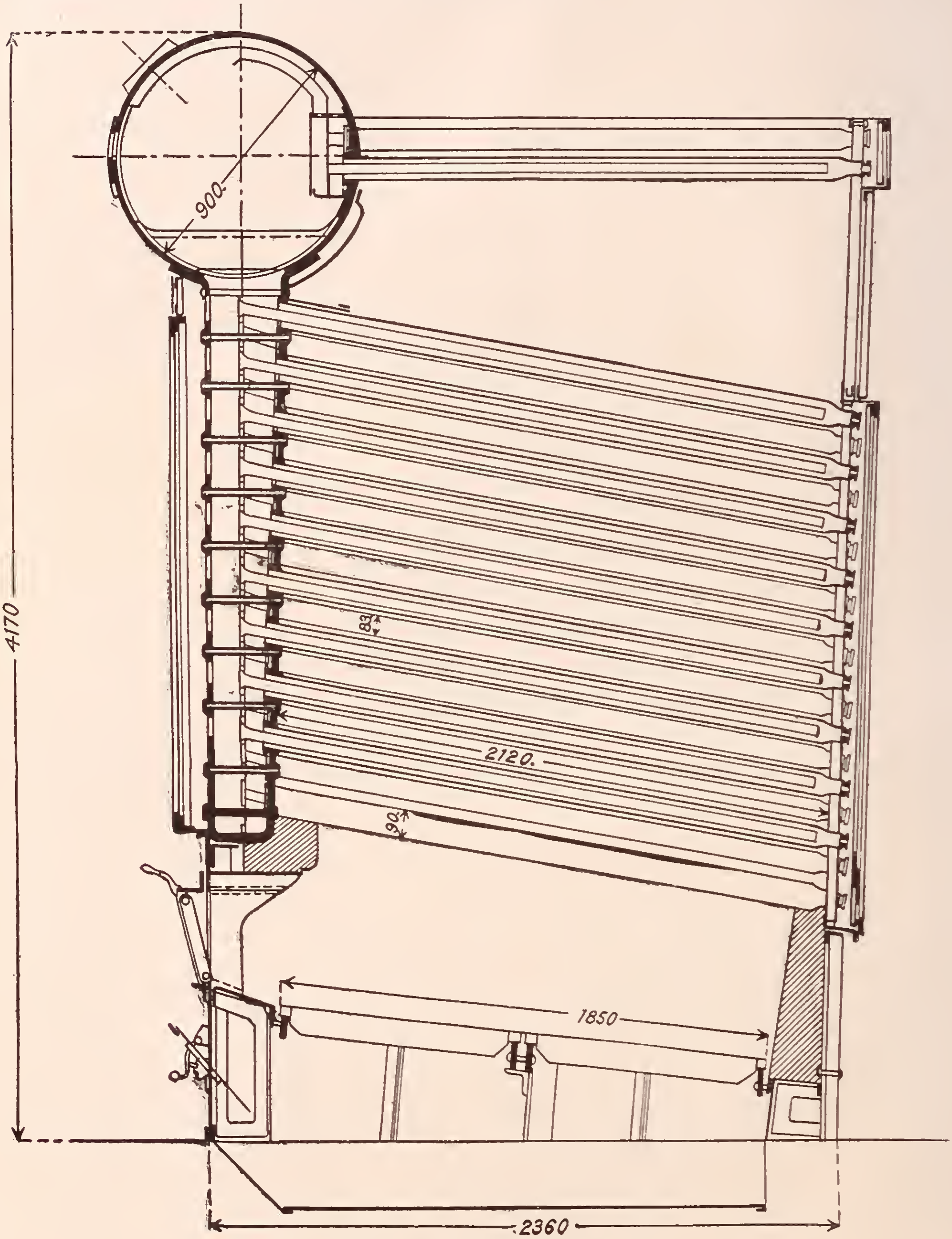
After the trials the tubes were found to be in perfect condition. The feed and combustion were both satisfactory. These boilers have been subjected to the test of banking fires when burning 82 pounds of coal per square foot of grate, emptying the boiler, changing the lower tier of tubes, refilling the boiler again, and resuming at the same rate of combustion, all in forty minutes.

The Normand boiler has been modified by placing two boilers back to back, with common steam and water chambers. The modified type is called the Normand-Segaudy boiler, and it has been installed on board the *Chateaurenault*. These boilers tried in the shops developed 1,800 H. P., with a working pressure of 215 pounds per square inch, under 2 inches of forced draft. Grate area, 64.5 square feet; heating surface, 1,615 square feet; volume of water, 153 cubic feet; volume of steam, 86 cubic feet; total weight of boiler, 22 tons. The only trouble found with these boilers on board ship has been due to insufficient feed and poor ventilation, as shown in the trials of the *Dunois*.

GERMANY.

The German service has tried various types of water-tube boilers—Belleville in the *Hertha*, Dürr in the *Victoria Luise*, Niclausse in the *Freya*, and Thornycroft with the Schultz improvements in the *Kaiser Friederich III*, *Aegir*, and *Würtemburg*. As a result, it is probable that the Dürr, a German boiler, will be adopted for the navy, although the four projected battleships are to have one-half or one-fourth boiler power in Thornycroft boilers. The following vessels have Dürr boilers: *Sachsen*, 8; *Baden*, 8; *Rhein*, 1; *Victoria Luise*, 12; *Vineta*, 12; and *Cruiser A*, 14.

The Dürr water-tube boiler is a modification of the Niclausse, in which the tubes, instead of being continuous through the header, stop at the inside plate of header for the outer tubes and at the diaphragm of the header for the inner tubes. The consequent loss of rigidity in the header is made up by through bolts, and the inner tubes are kept centered in the outer ones by means of springs. The rear ends of the outer tubes are closed by coned stoppers seated by pressure from the inside and held by a through bolt and nut set up on the outside. To remove a tube the cap holding the corresponding plate on the front of the boiler is unscrewed and the plate pushed in. The inner tube can then be removed by hand, being secured to the diaphragm by a locking ring. The outer tube is then started from its coned seat by a light blow on its rear end and drawn out through the hole in the front of the boiler. The joints are coned and are kept tight by the pressure. It is desirable to have 20 inches clear space behind this boiler to facili-



DÜRR WATER-TUBE BOILER.

tate cleaning, backing out tubes, flushing, etc. There is on trial an arrangement for cleaning tubes by which a flexible tube can be joined to the rear end of a boiler tube while the boiler is under pressure, and by opening a cock the tube is flushed out. Another system under trial admits of flushing all tubes at once.

The advantages claimed for the Dürr boiler are reported to be as follows:

(1) Can be rapidly dismounted without special tools.

(2) Very active circulation.

(3) No water can be carried over into the steam spaces, as the exit into the steam drum is large, steaming surfaces are ample, and steam must pass through the superheater.

(4) When empty the Dürr boiler is lighter per square foot of grate than the Belleville, Niclausse, or D'Allest.

(5) It contains no more water than these boilers.

(6) Although containing more water per square foot of grate, it is lighter than these boilers.

(7) The horsepower per square foot of grate is greater.

(8) The weight is less per horsepower.

(9) It is more economical, burning less coal for the same power.

(10) The Dürr boiler can without damage stand any rate of combustion and sudden changes.

(11) The construction is more simple and solid.

The following comparisons have been made in Germany:

	Belleville-Hertha.	Niclausse-Freya.	Dürr.	
			Victoria Luise.	Vineta.
Horsepower	10,173	10,226	10,863	[1]10,000
Grate surface.....square feet..	794.4	807.3	674.2	604
Heating surface.....do....	23,830	26,400	27,820	26,010
Space occupied, including fire room.....do....	3,326	3,326	3,326	3,326
Space occupied, excluding fire room.....do....	1,284	1,410	1,101	1,004

[1] Estimated.

The comparison between results of official trials is found below:

	Belleville.				Niclausse.	Dürr.
	Alger.	Latouche Tréville.	Bugeaud.	Bouvet.	Friant.	Victoria Luise.
Total weight.....tons..	437.5	347.5	407.4	580.3	363.2	391.7
Horsepower per square foot grate.....	10.9	11.1	12.6	12.3	12.2	16
Weight per horsepower.....pounds..	117.9	88.7	95.1	92.7	87.8	80.6
Quantity water in boilers.....tons..	10.4	17.8	15.9	29.1	45.2	59

Of the two sister ships the *Freya*, fitted with Niclausse boilers, and the *Victoria Luise*, fitted with Dürr boilers, the latter on her trials developed an average of 16 I. H. P. per square foot of grate, as compared with 12.6 I. H. P. per square foot of grate for the *Freya*.

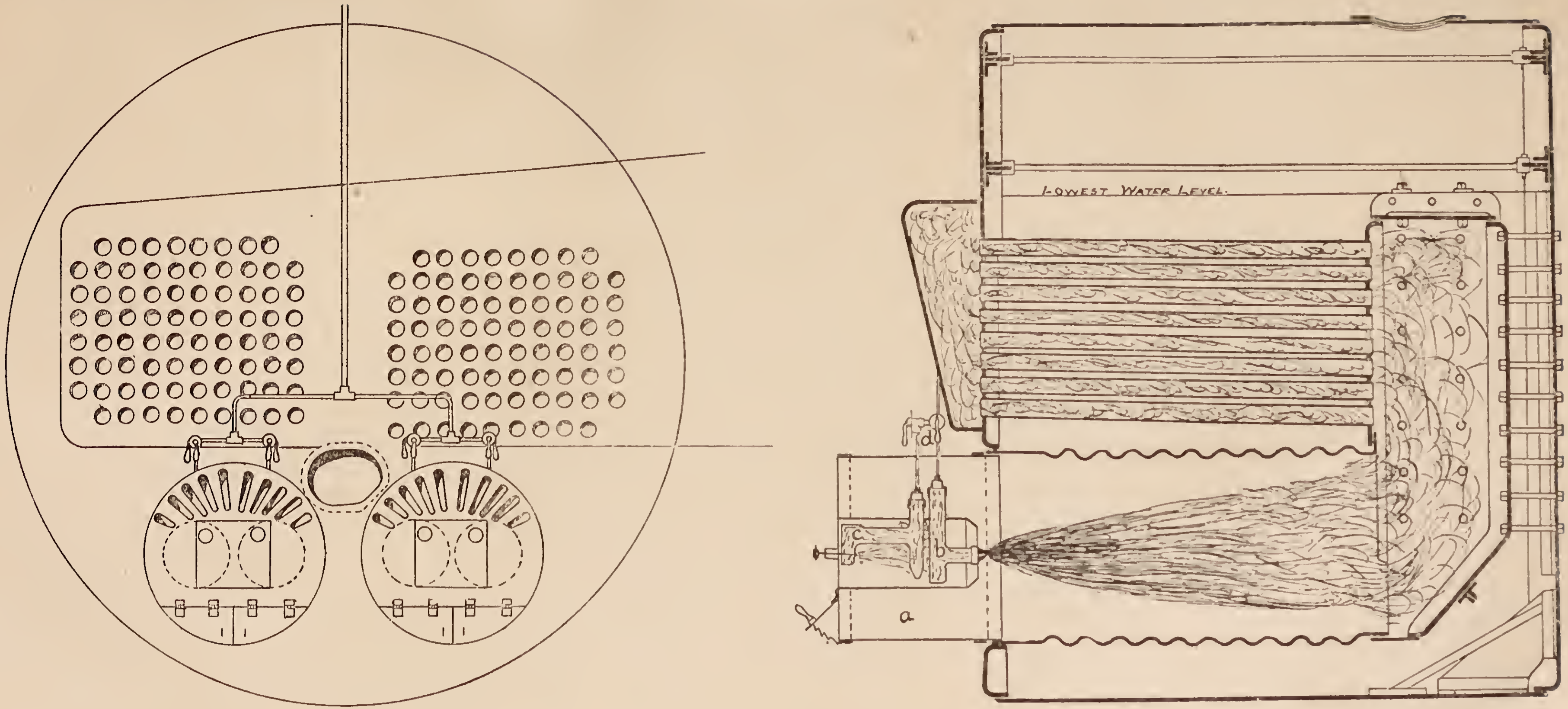
The Dürr system of burning petroleum gas in boilers is reported to have succeeded in Germany, and with absolutely no smoke. The necessary boiler attachment consists of a steel cylindrical box in front of the furnace door, which it replaces. This box contains the apparatus for converting the crude petroleum into gas, which is at once ignited, sending forth long flames which sweep through the furnace and tubes as indicated in the cut. The cylindrical box *a* has openings to control the draft and supports the gas-producing parts. The gas producer *c* is smaller than *b* and operates to heat the latter. The two are similar. Crude petroleum full of impurities is admitted through a pipe from the tank under a pressure of 45 pounds, the flow being regulated by a cock *d* to either or both gas producers *b* and *c*. The internal volume, heat and pressure in the producers convert the oil into gas.

The oil admitted into *c* flows into the horizontal part of the producer. A torch or lamp is then applied to the outside of *c*, and the heated oil, under the pressure of 3 atmospheres, in *c* is converted into gas and finds exit in a jet the size of a needle, which is lighted. This jet heats the producer *b*, and the latter undergoes the same operation, supplying a large volume of gas for consumption in the boiler. The drop portions of *b* and *c* are cups to collect the residuum, sand and other impurities in the crude petroleum. The fire may be extinguished at any time by simply closing the valve that admits the oil to the gas producers. The producers are made of cast iron and are inexpensive, and when one becomes choked with residuum another can be shipped in its place.

In a trial of seven hours duration given this system by The North German Lloyd Company 1,940 pounds of petroleum were consumed and 23,369 pounds of water evaporated, or at the rate of 12 pounds of water per pound of petroleum. The feed water varied in temperature from 111° F. to 156° F. A second trial in September last of six hours duration showed an improvement. On this occasion 3,858 pounds of petroleum were consumed and 38,558.7 pounds of water evaporated, or at the rate of 9.9 pounds of water per pound of petroleum. In this trial the feed water varied in temperature from 57° F. to 71° F.

RUSSIA, ITALY, AND OTHERS.

The Russian navy uses Belleville and Niclausse boilers for the large vessels and the Yarrow for the smaller craft. According to press reports some objections to the Belleville boilers exist. It is too difficult to feed and the circulation is not satisfactory, coupled with a liability to prime. The coal expenditure at full power is too large and the boilers are not firmly enough installed to withstand rolling in heavy weather. It is understood that a Russian engineer has devised modi-



a, Gas-generator box; *b*, forwerd gas generator; *c*, after gas generator; *d*, valve admitting petroleum.

PETROLEUM-GAS FIRING FOR BOILERS. (Dürr system.)

fications to the Belleville boiler resulting in 25 per cent economy in fuel and improved circulation and feed, which may result in the adoption of this improved type for vessels now on the stocks.

Belleville and Niclausse boilers have been adopted by the Italian Government and worn-out boilers in the old ships are to be replaced by the Belleville.

The Martinelli, an Italian boiler with five rows of straight tubes inclined slightly upward from front to rear, with three water and steam drums on top running the same way and having hollow grate bars with air holes, has been installed for trial on one of the new torpedo boats. This boiler is readily cleaned and is economical, though the first cost is great,owing to expensive locks used for securing the tubes in place.

Holland and Sweden use the Yarrow boiler for both large and small vessels. Austria has adopted the Belleville and Dürr boilers for large vessels and the Yarrow for small vessels. Japan puts the Belleville boiler in ships and the Yarrow and Normand in torpedo boats.

STEAM TURBINES.

The adoption of the steam turbine by the British Admiralty as the motive power of the new destroyer *Viper*, and the apparently successful preliminary trials of that vessel, arrest the attention of naval men, as the possible beginning of a new era in torpedo boat construction.

The type of turbine adopted by England is an improved form of the Parsons steam turbine as used in the *Turbinia*. This turbine has been fully described in engineering publications, and officers are familar with its general features. Mr. Parsons, the inventor, gives the following information which brings the matter up to date:

> The application of the compound steam turbine to the propulsion of vessels is a subject of considerable general interest in view of the possible and probable general adoption of this class of engine in fast vessels.
>
> In the turbine is found an engine of extremely light weight, with a perfectly uniform turning moment, and very economical in steam in proportion to the power developed, and further it can be perfectly balanced so that no perceptible vibration is imparted to the ship. The problem of proportioning the engine to the screw propellers and to the ship to be driven has been the subject of costly experiments extending over several years, with the result that a satisfactory solution has been found giving very economical results in regard to pounds of steam consumed in the engines per effective horse power developed in propelling the vessel, results which are equal or superior to those so far obtained with triple expansion engines of ordinary type in torpedo boats, or torpedo-boat destroyers. The arrangement adopted may be best described by saying that instead of placing as usual one engine to drive one screw shaft the turbine engine is divided into two, three, or sometimes more, separate turbines, each driving a separate screw shaft, the steam passing successively through these turbines. Thus when there are three turbines driving three shafts the steam from the boiler passes through the high pressure turbine, thence through the intermediate, and lastly through the low, and thence to the condenser.
>
> As to the propellers, these approach closely to the usual form. It has, however, been found best to place two propellers of approximately the same pitch on each

shaft at some considerable distance apart, so that the after one shall not be seriously affected by the wash of the one in front. The advantage of this arrangement is that a sufficient blade area is obtained to carry the thrust necessary to drive the vessel with a lesser diameter of propeller, and so permitting a higher speed of revolution of the engines.

The problem was complicated by the question of cavitation, which, though previously anticipated, was first practically found to exist by Mr. Thornycroft and Mr. Barnaby in 1894, and by them it was experimentally determined that cavitation, or the hollowing out of the water into vacuous spaces and vortices by the blades of the propeller, commences to take place when the mean thrust pressure on the projected area of the blades exceeds 11¼ pounds per square inch. This limit has since been corroborated during the trials of the *Turbinia.*

This phenomenon has also been further investigated in the case of model propellers working in an oval tank of water, and to permit of cavitation at more moderate speeds than would otherwise have been necessary the following arrangement was adopted: The tank was closed, plate-glass windows being provided on each side, through which the propeller could be observed and the atmospheric pressure was removed from the surface of the water by an air pump. Under this condition the only forces tending to prevent cavitation were the small head of water above the propeller, and capillary attraction.

In the case of a propeller of 2 inches in diameter cavitation commenced at about 1,200 revolutions and became very pronounced at 1,500. Had the atmospheric pressure not been removed, speeds of 12,000 and 15,000 respectively would have been necessary.

Photographs were taken with a camera made for the purpose with a focal plane shutter giving an exposure of about one-thousandth of a second, the illumination being by sunlight concentrated on the propeller from a 24-inch concave mirror.

Photographs were also taken by intermittent illumination of the propeller from an arc lamp, the arrangement consisting of an ordinary lantern condenser, which projected the beam on to a small concave mirror, mounted on a prolongation of the propeller shaft, the reflected beam being caught by a small stationary concave mirror at a definite position in each revolution and reflected on to the propeller. By this means the propeller was illuminated in a definite position at each revolution, and to the eye it appeared as stationary. The cavities about the blades could also be clearly seen and traced. The photographs being taken with an ordinary camera and about ten seconds exposure.

A series of experiments was also made with model propellers in water at and just below the boiling point, dynamometric measurements being taken of power and thrust with various widths of propeller blade, the conclusion arrived at being that wide and thin blades are essential for fast speeds at sea, as well as a coarse pitch ratio of propeller.

The first vessel fitted with steam turbine machinery was the *Turbinia.* She was commenced in 1894, and after many alterations and preliminary trials was satisfactorily completed in the spring of 1897. Her principal features are: Length, 100 feet; beam, 9 feet; 5 feet draught of water under the propellers; 44½ tons displacement on trial. She is fitted with a water-tube boiler of 1,100 square feet total heating surface, and forty-two square feet of grate area, with closed stokeholes supplied with air from a centrifugal fan mounted on a prolongation of the low pressure turbine shaft. The engines consist of three compound steam turbines, high pressure, intermediate, and low pressure, each driving one screw shaft. On each of the shafts are three propellers, making nine in all. The condenser is of the usual type, and has 4,000 square feet of surface.

When officially tested by Professor Ewing, F. R. S., assisted by Professor Dunkerly, she attained a mean speed on the measured mile of 32¾ knots, and the consumption of steam for all purposes was computed to be 14½ pounds per I. H. P. of the main engines. Subsequently, after some small alterations to the steam pipe, she was further pressed and is estimated to have reached the speed of 34½ knots. She was and still is, therefore, the fastest vessel afloat. She has been out in very rough weather, is an excellent sea boat, and at all speeds there is an almost complete absence of vibration.

In the *Turbinia* the exceptional speed results principally from two causes: (1) The engines, screws, and shafting are exceptionally light. (2) The economy of steam in the main engines is greater than usual.

At full speed the steam presssure in the boiler is 210 pounds, at the engines 175 pounds, and the vacuum in the condenser 27 inches, representing an expansion ratio in the turbines of about 110 after allowance has been made for wire drawing in the exhaust pipe.

The first vessels of larger size than the *Turbinia* to be fitted with steam turbine machinery are the torpedo-boat destroyer *Viper*, for the British Government, and a similar vessel for Messrs. Sir W. G. Armstrong, Whitworth & Co.

These vessels are of approximately the same dimensions as the 30-knot destroyers now in Her Majesty's service, but have slightly more displacement. The boilers are about 12 per cent larger, and it is estimated that upwards of 10,000 H. P. will be realized under the usual conditions as against 6,500 with reciprocating engines.

The engines of these vessels are in duplicate. Two screw shafts are placed on each side of the vessel, driven respectively by a high and a low pressure turbine; to each of the low-pressure turbine shafts a small reversing turbine is permanently coupled for going astern, the estimated speed astern being 15½ knots and ahead 35 knots; two propellers are placed on each shaft.

The latter of these two vessels has commenced her preliminary trials, and has already reached a speed of 32 knots. The manipulation of the engines is a comparatively simple matter, as to reverse it is only necessary to close one valve and open another, and owing to there being no dead centers small graduations of speeed can be easily made.

In regard to the general application of turbine machinery to large ships the conditions appear to be more favorable in the case of the faster class of vessels, such as cross-channel boats, faster passenger vessels, cruisers and liners; in such vessels the reduction in weight of machinery as well as economy in the consumption of coal per horsepower are important factors in the case, and in some vessels the absence of vibration, both as regards the comfort of passengers and in the case of ships of war permitting greater accuracy in sighting the guns, is a question of first importance.

As regards cross-channel boats the turbine system presents advantages in speed, absence of vibration, and, owing to the smaller diameter of the propellors, reduced draught.

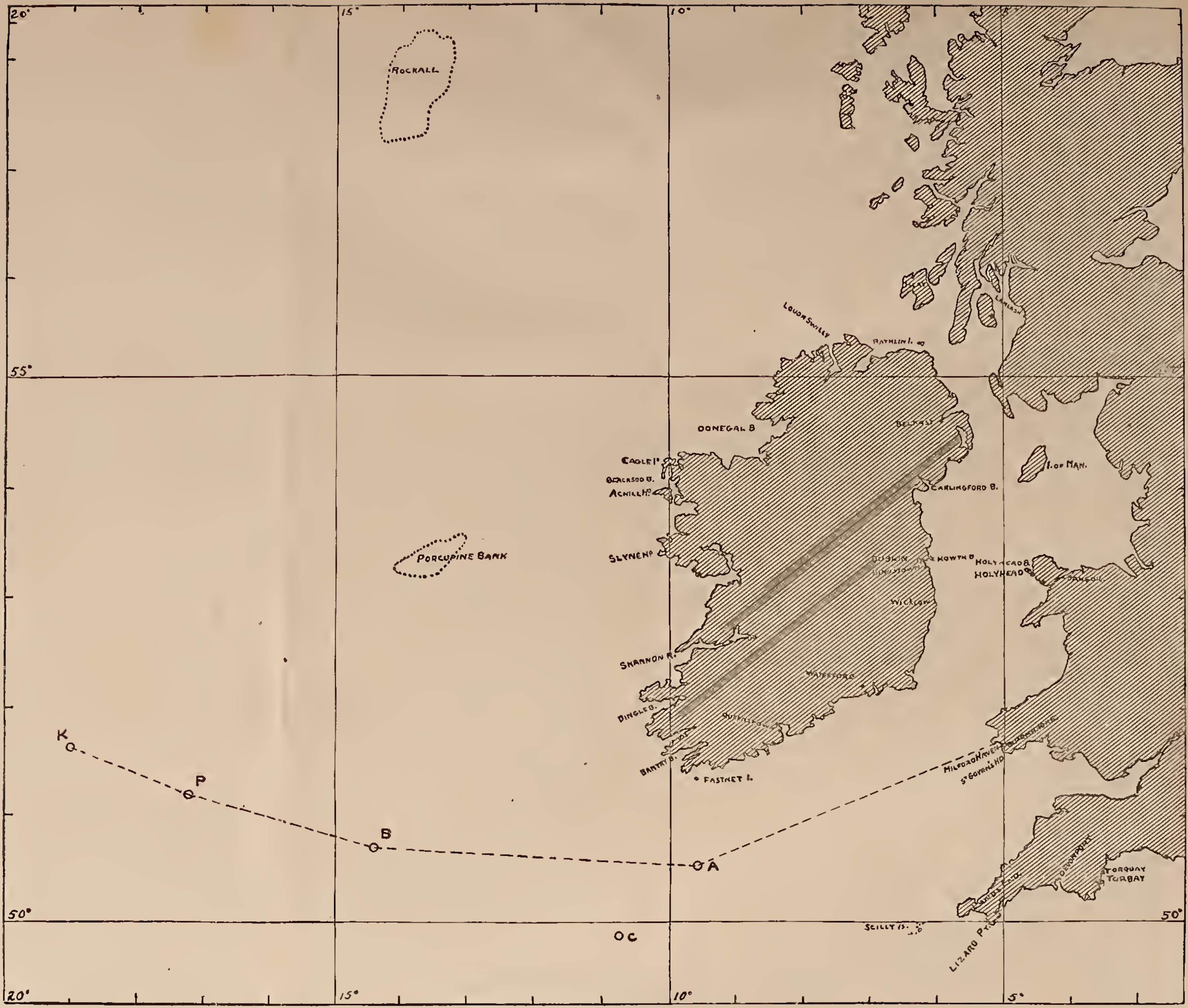
As an instance, a boat of 270 feet length, 33 feet beam, 1,000 tons displacement, and 8 feet 6 inches draught of water could be constructed with spacious accommodation for 600 passengers, and with machinery developing 18,000 H. P.; she would have a sea speed of about 30 knots, as compared with the speed of 19 to 22 knots of the present vessels of similar size and accommodation.

It is, perhaps, interesting to examine the possibilities of speed that might be attained in a special unarmored cruiser, a magnified torpedo-boat destroyer of light build with scanty accommodations for her large crew, but equipped with an armament of light guns and torpedoes. Let us assume her dimensions to be about double those of the 30-knot destroyers, with plates of double the thickness and specially strengthened to correspond with the increased size; length 420 feet, beam 42 feet, maximum draught 14 feet, displacement 2,800 tons, and indicated horsepower 80,000; there would be two tiers of water-tube boilers, which with the engine space, coal bunkers, etc., would occupy the whole of the lower portion of the vessel; the crew's quarters and guns would be on the upper decks. There would be 8 propellers of 9 feet in diameter revolving at about 400 revolutions per minute, and her speed would be about 44 knots.

She could carry coal at this speed for about eight hours, but she would be able to steam at from 10 to 14 knots with a small section of the boilers more economically than other vessels of ordinary type and power, and when required, all the boilers could be used, and full power exerted in about half an hour.

In the case of an Atlantic liner or a cruiser of large size, turbine engines would appear to present some considerable advantages. In the first place they would effect a reduction in weight of machinery, and some increase in economy of fuel per horse-power developed, both thus tending either to a saving in coal on the one hand, or, if preferred, some increase in speed.

The advantages are, however, less pronounced in this class of vessel on account of the smaller relative power of the machinery, and the large quantity of coal necessary for long voyages, but the complete absence of vibration at all speeds, not to mention many minor considerations of saving in cost and reduced engine-room staff, are questions of considerable importance.



SCENE OF OPERATIONS, ENGLISH MANŒUVRES.

VIII.

NAVAL MANŒUVRES, 1899.

By Lieut. William L. Howard, United States Navy, *Staff Intelligence Officer.*

ENGLAND.

July 11 was the date selected by the Admiralty for the annual "partial mobilization of the fleet." Although it was termed a "partial mobilization," there were comparatively few effective ships left in the naval ports after the manœuvreing squadrons put to sea, excepting the new vessels nearing completion.

The annual manœuvres were omitted last year for various reasons—principally the South Wales coal strike—and it was the intention of the Admiralty to make this year's mobilization the most extensive of any yet attempted. The mobilization differed little from that of former years. Both the Channel and Reserve squadrons took part in the assembly, and were joined by a large number of ships specially commissioned for the manœuvres. The following tables show the number of ships commissioned at the several ports and those which, being in commission, required men to bring their crews to a war complement.

Class.	At Portsmouth.	At Devonport.	At Chatham.	Total.
Ships commissioned:				
Cruisers, first class	3	....	1	4
Cruisers, second class	5	11	10	26
Destroyers	2	2	2	6
Torpedo boats	10	6	7	23
Total	20	19	20	59
Ships whose complements were completed:				
Battleships	3	6	1	10
Cruisers, first class	1	....	1	2
Cruisers, second class	....	1	1	2
Gunboats	2	1	3	6
Torpedo boats	....	1	....	1
Total	6	9	6	21
Grand total	26	28	26	80

This total of 80 ships represents the vessels of the Reserve Squadron and ships specially commissioned. In addition to these there were the 8 first-class battleships of the Channel Squadron, the 6 cruisers which form the scouts of this squadron, and 24 destroyers and torpedo boats, making a total of 118 vessels of various classes.

The general scheme of the Admiralty differed materially, both in conception and in the rules and regulations issued for its execution, from any manœuvres heretofore carried out. Its objects were officially defined in the following terms:

> The principal object of the 1899 manœuvres is to obtain information as to the most advantageous method of employing a considerable body of cruisers in conjunction with a fleet.
>
> A subsidiary object is to throw some light on the relative advantages and disadvantages of speed and fighting strength.
>
> Another subsidiary object is to obtain information relative to the working of destroyers and torpedo boats.

GENERAL IDEA OF MANŒUVRES.

A British convoy (C) of slow ships escorted by a fast cruiser, on passage from Halifax to Milford Haven, is ordered to wait at a certain rendezvous the arrival of a protecting squadron.

N. B.—The slow ships can not be taken in tow, must remain in company, and have no fighting value.

A hostile squadron (A) of fast ships lying at Belfast is sent to sea to intercept and capture the convoy and bring it into Belfast.

After an interval a superior British squadron (B) of slower ships is sent to protect the convoy (C), which has been ordered to a prearranged rendezvous, cover it from the hostile squadron, and bring it into Milford.

The whole of Ireland is hostile territory and belongs to A.

The coast of England and Wales from the island of Islay to the Lizard, including the Scillies and the Isle of Man, is British territory.

The hostile fleet (A) has torpedo boats at Waterford, Kingstown, and Belfast.

The British fleet (B) has destroyers at Milford Haven, Holyhead, and Lamlash.

Composition and strength of the fleets.

"A" FLEET—CHANNEL.

[Vice-Admiral Sir HARRY H. RAWSON, K. C. B.; Rear-Admiral ARTHUR D FANSHAWE, second in command.]

Ships.	Displacement.	I. H. P.		Completed.	Guns, main battery.	Maximum speed.	Normal coal Supply.	Complement.	Boilers.[1]
		Natural.	Forced.						
Battleships, first-class.	*Tons.*					*Knots.*	*Tons.*		
Majestic[2]	14,900	10,000	12,000	1895	16	17.5	1,850	757	C.
Hannibal	14,900	10,000	12,000	1897	16	17.5	1,850	757	C.
Prince George	14,900	10,000	12,000	1896	16	17.5	1,850	757	C.
Mars	14,900	10,000	12,000	1897	16	17.5	1,850	757	C.
Jupiter	14,900	10,000	12,000	1897	16	17.5	1,850	757	C.
Magnificent[3]	14,900	10,000	12,000	1895	16	17.5	1,850	757	C.
Repulse	14,150	9,000	13,000	1894	14	17.5	1,800	730	C.
Resolution	14,150	9,000	13,000	1893	14	17.5	1,800	730	C.
Cruisers, first-class.				*Launched*					
Diadem	11,000	11,000	16,500	1896	16	20.5	1,000	600	B.
Niobe	11,000	11,000	16,500	1897	16	20.5	1,000	600	B.
Andromeda	11,000	11,000	16,500	1897	16	20.5	1,000	600	B.
Cruisers, second class.									
Mersey	4,050	4,000	6,000	1885	12	17.3	900	327	C.
Thames	4,050	3,800	5,700	1885	12	16.8	900	326	C.
Pique	3,600	7,000	9,000	1890	8	19.75	400	273	C.
Terpsichore	3,400	7,000	9,000	1890	8	20	400	275	C.
Arrogant	5,800	10,000	....	1896	10	19.1	500	480	B.
Minerva	5,600	8,000	9,600	1895	11	20.3	550	437	B.
Sybille	3,400	7,000	9,000	1890	8	20	400	273	C.
Cambrian	4,360	7,000	9,000	1893	10	19.5	400	312	C.
Latona	3,400	7,000	9,000	1890	8	20	400	273	C.
Naiad	3,400	7,000	9,000	1890	8	20	400	273	C.
Æolus	3,600	7,000	9,000	1892	8	19.75	400	273	C.
Retribution	3,600	7,000	9,000	1891	8	19.75	400	275	C.
Arethusa	4,300	5,000	....	1882	10	16.6	1,000	309	C.
Furious	5,800	10,000	....	1896	10	19	500	480	B.
Cruisers, third-class.									
Pactolus	2,135	5,000	7,000	1897	8	20	250	224	B.
Pelorus	2,135	5,000	7,000	1896	8	20	250	224	B.

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[1] B, Belleville; C, cylindrical.

[2] Flagship of Vice-Admiral Sir Harry H. Rawson, K. C. B.

[3] Flagship of Rear-Admiral Arthur D. Fanshawe.

Composition and strength of the fleets—Continued.

"B" FLEET—RESERVE.

[Vice-Admiral Sir COMPTON E. DOMVILLE, K. C. B.; Rear-Admiral PELHAM ALDRICH, second in command.]

Ships.	Displacement.	I. H. P.		Completed.	Guns, main battery.	Maximum speed.	Normal coal supply.	Complement.	Boilers.[1]
		Natural draft.	Forced draft.						
Battleships—First class.	*Tons.*					*Knots.*	*Tons.*		
Trafalgar	11,940	7,500	12,000	1890	10	16.7	1,200	572	C.
Nile	11,940	7,500	12,000	1890	10	16.7	1,200	558	C.
Sans Pareil[2]	10,470	7,500	14,000	1889	15	17.2	1,200	583	C.
Benbow	10,600	7,500	11,500	1888	12	16.75	1,200	509	C.
Howe	10,300	7,500	11,500	1889	10	16.8	1,200	515	C.
Rodney	10,300	7,500	11,500	1888	10	16.75	1,200	515	C.
Collingwood	9,500	7,500	9,500	1886	10	16.5	1,200	480	C.
Battleships—Second class.									
Alexandra[3]	9,490	7,000	....	1877	18	14.3	680	600	C.
Thunderer	9,330	5,500	7,000	1877	10	14	1,600	592	C.
Colussus	9,420	5,500	....	1886	9	14.2	970	388	C.
Cruisers—First class.				*Launched.*					
Europa	11,000	11,000	16,500	1897	16	20.5	1,000	600	B.
Argonaut	11,000	11,000	18,000	1898	16	20.75	1,000	677	B.
St. George	7,700	10,000	12,000	1892	12	19.7	850	559	C.
Galatea	5,600	5,500	8,500	1889	12	18.1	900	484	C.
Cruisers—Second class.									
Forth	4,050	3,800	5,700	1886	12	16.8	900	326	C.
Severn	4,050	4,000	6,000	1885	12	17.3	900	327	C.
Andromache	3,400	7,000	9,000	1890	8	20	400	273	C.
Sappho	3,400	7,000	9,000	1891	8	20.47	400	273	C.
Vindictive	5,800	10,000	....	1896	10	19.5	500	450	C.
Diana	5,600	8,000	9,600	1895	11	20	550	470	B.
Sirius	3,600	7,000	9,000	1890	8	19.75	400	273	C.
Charybdis	4,360	7,000	9,000	1893	10	19.5	400	312	C.
Melampus	3,400	7,000	9,000	1890	8	20	400	273	C.
Apollo	3,400	7,000	9,000	1891	8	20	400	273	C.
Spartan	3,600	7,000	9,000	1891	8	19.75	400	273	C.
Brilliant	3,600	7,000	9,000	1891	8	19.7	400	273	C.
Mercury	3,730	6,000	....	1878	13	16.8	780	291	C.
Gladiator	5,800	10,000	....	1896	10	19	500	480	B.
Juno	5,600	8,000	9,600	1895	11	20	550	470	B.
Rainbow	3,600	7,000	9,000	1891	8	19.7	400	273	C.

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[1] B.—Belleville; C.—Cylindrical.

[2] Flagship of Rear Admiral Pelham Aldrich.

[3] Flagship of Vice-Admiral Sir Compton E. Domville, K. C. B.

Composition and strength of the fleets—Continued.

TORPEDO BOATS—"A" FLEET.

Name or number.	Displacement.	I. H. P., forced draft.	Date of launch.	Maximum speed.	Normal coal supply.	Complement.	Boilers.[1]	Torpedo tubes.
	Tons.			*Knots.*	*Tons.*			
Spanker [2]	735	3,500	1889	20	100	91	Du T.	3
42	60	700	1886	21	....	15	....	4
66	75	700	1886	19-20	20	15	....	5
71	75	700	1886	19-20	20	15	....	5
76	75	700	1886	19-20	20	15	....	5
77	75	700	1886	19-20	20	15	....	5
79	75	1,000	1886	22.4	20	15	....	....
81	125	....	1885	20	35	25	....	3
84	85	1,100	1889	23	20	19	....	3
Gossamer [2]	735	3,500	1890	19	100	91	C.	3
63	75	700	1886	19-20	20	15	....	5
64	75	700	1886	19-20	20	15	....	5
65	75	700	1886	19-20	20	15	....	5
68	75	700	1886	19-20	20	15	....	5
72	75	700	1886	19-20	20	15	....	5
73	75	700	1886	19-20	20	15	....	5
74	75	700	1886	19-20	20	15	....	5
83	85	1,100	1889	23	20	19	....	3
Jason [2]	810	3,500	1892	19.25	100	91	C.	3
45	60	700	1886	21	....	15	....	4
49	60	700	1886	21	....	15	....	4
52	60	700	1886	21	....	15	....	4
53	60	700	1886	21	....	15	....	4
55	60	700	1886	21	....	15	....	4
57	60	700	1886	21	....	15	....	4
58	60	700	1886	21	....	15	....	4
86	85	1,100	1889	23	20	19	....	3

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[1] Du T.=Du Temple; C.=Cylindrical.

[2] Torpedo gunboat.

Composition and strength of the fleets—Continued.

DESTROYERS—"B" FLEET.

Name.	Displacement.	I. H. P., forced draft.	Date of launch.	Maximum speed.	Normal coal supply.	Complement.	Boilers.[1]	Armament.
	Tons.			*Knots.*	*Tons.*			
Leda[2]	810	3,500	1892	19.25	100	91	C.	Two 4.7-inch; four 3-pounders; 3 tubes.
Crane	324	5,900	1896	30.3	80	60	......	One 12-pounder; five 6-pounders; 2 tubes.
Chamois	325	6,200	1896	30.3	80	60	......	Do.
Hunter	260	4,000	1895	27.2	....	......	......	Do.
Flying Fish	324	6,200	1897	....	80	58	......	Do.
Lightning	252	3,900	1895	27.94	60	50	......	Do.
Star	328	5,900	1896	30.6	80	58	......	Do.
Violet	360	6,000	1897	30.3	80	58	......	Do.
Teazer	270	4,500	1895	27	60	50	......	Do.
Fawn	324	5,900	1897	30	80	60	......	Do.
Sylvia	283	6,000	1897	30	80	58	......	Do.
Niger[2]	810	3,500	1892	19.25	100	91	C.	Two 4.7-inch; four 3-pounders; 3 tubes.
Angler	278	5,700	1896	30.37	80	60	......	One 12-pounder; five 6-pounders; 2 tubes.
Haughty	265	4,200	1895	27.1	60	50	......	Do.
Cygnet	285	5,400	1898	30	80	60	......	Do.
Contest	290	4,400	1894	27.4	....	50	......	Do.
Janus	252	3,900	1895	27.8	60	50	......	Do.
Mallard	275	5,700	1896	30.11	80	58	......	Do.
Porcupine	288	3,900	1895	27.91	60	50	......	Do.
Dasher	250	3,800	1895	26.21	60	45	......	Do.
Renard[2]	810	3,500	1892	19.25	100	91	C.	Two 4.7-inch; four 3-pounders; 3 tubes.
Bat	300	5,900	1896	30	80	60	......	One 12-pounder; five 6-pounders; 2 tubes.
Ferret	280	4,400	1893	27.62	70	50	......	One 12-pounder; three 6-pounders; 3 tubes.
Lynx	280	4,400	1894	27	70	50	......	Do.
Panther	300	6,300	1897	30.14	80	58	......	One 12-pounder; five 6-pounders; 2 tubes.
Seal	300	6,300	1897	30.15	80	58	......	Do.
Shark	280	4,100	1894	27.59	60	50	......	Do.
Thrasher	300	6,300	1896	30.13	80	58	......	Do.
Wolf	300	6,300	1897	30	80	58	......	Do.
Fairy	300	6,500	1897	32	80	60	......	Do.
Gipsy	300	6,500	1897	32	80	60	......	Do.

[1] C.=Cylindrical.

[2] Torpedo gunboat.

CONVOY.

Caliope and Curaçoa, slow ships.
A first-class cruiser to be detached from B, escort.

RULES AND REGULATIONS GOVERNING THE MANŒUVRES.

The ports of Belfast and Milford Haven are to be considered as strongly fortified and proof against torpedo attack within the following limits:

Belfast, within a line drawn from Black Head to Orlock Point.

Milford, within a line drawn from St. Anns Head to Sheep Island.

After hostilities have commenced ships outside these limits are liable to attack from any vessel of the enemy.

Destroyer and torpedo boat stations are proof against attack.

All other ports in the territories of the respective admirals are open and undefended, and can be used only by vessels of the side to which the ports belong at their own risk.

The signal stations marked on the special chart issued with the instructions for the distribution of intelligence will alone supply information during the manœuvres.

The fleets, with their respective flotillas, being at their respective base ports, will be warned by a telegram to "prepare for hostilities," upon which the flotillas, with their depot ships, will be sent off to their stations. Each fleet will be free to send out vessels of the flotillas, but none of them are to lie off an enemy's port during this time of preparation in such a manner as would be calculated to precipitate hostilities during a period of strained relations.

Not later than forty-eight hours after the telegram to "prepare," the telegram to "commence hostilities" will be sent, but no attempt is to be made by officers in command on either side to put a vessel out of action until it is known to them for certain that hostilities have begun.

All battleships are to be considered of equal power; the superiority of one battle squadron over another is to depend alone upon which has the greater number of battleships.

The following table will govern battleships, cruisers, and smaller vessels being put out of action:

Number and class of vessels.	Can put out of action.	At what distance.	In what time.
1 battleship	Battleship	Within 2 miles[1]	1 hour.
Do	Any cruiser	Within 3 miles	30 minutes.
1 first-class cruiser	First-class cruiser or ship of lower class.	Within 1 mile	Do.
1 second-class cruiser	Second-class cruiser or ship of lower class.	do	Do.
1 third-class cruiser	Third-class cruiser or ship of lower class.	do	Do.
2 cruisers of same class	1 cruiser of same class	do	Do.
1 torpedo gunboat	Torpedo gunboat	do	Do.
1 destroyer	Torpedo boat	Within one-fourth mile	5 minutes.
2 torpedo boats	Destroyer	do	Do.
Battleships, all cruisers, torpedo gunboats.	Destroyer, torpedo boat	Within 1,000 yards	3 minutes.

[1] In the case of squadrons this distance will be that between the nearest ships.

The period of "action" is to be between the two guns which either ship may fire to mark it. The first is to be fired when the two ships are within the prescribed distance, and the second from the same ship at the expiration of the time allowed. No other guns than these are to be fired.

No ship can put two vessels out of action in the same time; each must have its separate time allowance.

No cruiser of a lower class can count against a cruiser of a higher class.

With squadrons of cruisers composed of more than two of the same class, if the superiority is less than two to one, one cruiser on the more numerous side will be put out of action as well as all the cruisers on the less numerous.

Ships put out of action, under the rules, can take no further part in the manœuvres, but must return to their port—Milford or Belfast—flying the "blue peter" at the fore. They are to select a route as far as possible clear of the scene of operations, and are strictly enjoined not to communicate any information to the ships on either side which they may meet on the way.

No battleships can be put out of action except by battleships or if torpedoed.

As the 18-inch torpedo can not be fired at a ship in a peace exercise, a destroyer is to fire a blue light at night or blow her whistle by day at the moment when the torpedo would be discharged, the tube being trained and all adjustments made as if actually firing. The distance at the time of firing must be within 500 yards, and the number of torpedoes considered successful will be assessed by the umpires.

Any vessel will be put out of action if a torpedo fired from a torpedo boat strikes her before the torpedo boat is herself out of action.

At the expiration of the period of hostilities, vessels which have returned to port will carry out such orders as they have received relative to target practice, and either return to ports of assembly or rejoin their squadrons, as may be ordered by the respective vice-admirals.

Any points which may arise, not provided for by these rules, will be decided by the umpires according to what, in their opinion, would be probable in war.

Umpires: Vice-Admiral Sir Cyprian Bridge, K. C. B.; Rear-Admiral John Fellowes; Rear-Admiral Swinton Holland.

MOBILIZATION.

The partial mobilization of the fleet took place at 9 a. m., July 11.

PORTSMOUTH.

Eight cruisers, two destroyers, and ten torpedo boats were specially commissioned to take part in the naval manœuvres. The organization was perfect, and the work of getting all the crews on board was performed in about half an hour. Steam was raised during the morning.

and during the afternoon all the smaller vessels left for Spithead. The cruisers, after a short steam trial, proceeded to their rendezvous on the 12th.

DEVONPORT.

Eleven cruisers, two destroyers, and six torpedo boats were commissioned. All the vessels in the western command that had been specially commissioned for the manœuvres had moved into Plymouth Sound by the morning of the 12th, and during that day were occupied with steam trials in the channel preparatory to leaving for their respective rendezvous.

CHATHAM.

Eleven cruisers and seven torpedo boats were commissioned. Torpedo boats left during afternoon for rendezvous in Plymouth Sound. Cruisers left July 12 for Tor Bay and Portland. The cruisers took in ammunition at Black Stakes.

The first rendezvous of the squadrons was: Portsmouth, destroyers; Portland, channel squadron; Tor Bay, reserve squadron; Plymouth, torpedo boats.

July 14 the torpedo flotilla exercised in steam tactics in the channel.

The Channel Fleet, with the exception of the *Pelorus*, assembled in Portland roadstead July 14.

The reserve fleet were all assembled in Tor Bay by July 16. The cruiser *Juno* had been fitted with the necessary apparatus and instruments for experiments in the Marconi system of wireless telegraphy and had Signor Marconi on board. A similar installation had been made on the flagship *Alexandra*, which carried two of Signor Marconi's assistants, and on the *Europa*.

PRELIMINARY EXERCISES.

The Channel Squadron left Portland at 9.30 a. m., July 17, for Belfast. Anchored in Lough Swilly the afternoon of July 20. Early on the 21st the cruisers *Niobe*, *Diadem*, *Arrogant*, *Furious*, *Minerva*, *Sybille*, *Arethusa*, and *Pactolus* were ordered to leave Lough Swilly for Belfast Lough and to coal there on Saturday before the arrival of the remainder of the fleet, which remained at Lough Swilly until the 22d. On the passage from Lough Swilly to Belfast Lough a speed trial of all the ships in company was held at three-fifths power. The trial lasted three hours. The *Andromeda* led the cruisers with a speed of 17.9 knots; the *Terpsichore* 16.8 knots. The poorest performances were the *Retribution*, with 14.8 knots, and the *Aeolus* with 13.3. The *Cambrian* and *Pique* each made 15 knots, the *Latona* 15.9, and the *Naid* 16.2; the *Majestic*, *Magnificent*, *Resolution*, and *Hannibal* 14 knots each; *Prince George* 14.9, *Repulse* 14.5, and the *Jupiter* and *Mars* 14.2 knots each.

The cruisers sent in advance carried out a similar trial on their way with the following results: *Diadem* first, with a speed of 18.3 knots; *Niobe* 17.9, *Sybille* 17.6, *Furious* 17.3, *Arrogant* 17.2, *Minerva* 16.8, *Pactolus* 15.5, and the *Arethusa* 14.3.

Coaling began at 5 a. m. on the 22d on these cruisers and was finished shortly after noon. The *Diadem* led, taking in 645 tons at an average of 91 tons per hour. At 4.15 p. m. the battle fleet anchored in Belfast Lough. The greater part of the torpedo flotilla arrived later in the afternoon, followed by the remainder at midnight.

The battle fleet commenced coaling the 24th. The *Mars* was four hours and forty minutes taking in 582 tons of coal, an average of 131.7 tons per hour. The following table gives the quantity of coal taken by each ship, with hourly averages.

Name.	Tons.	Hourly average.	Name.	Tons.	Hourly average.
Mars	582	131.77	Retribution	268	32.81
Majestic	500	109.09	Pactolus	200	33.3
Magnificent	388	103.46	Minerva	347	56.27
Resolution	562	93.3	Niobe	800	84.2
Repulse	420	93.3	Furious	512	76.8
Prince George	550	73.3	Diadem	645	91.05
Latona	255	38.2	Sybille	203	35.82
Arrogant	460	78.8	Arethusa	276	92.57

The reserve fleet left Tor Bay at 10 a. m., July 17, and anchored off Berehaven about 6 p. m., July 20, exercising at tactical evolutions, the cruisers exercising at scouting and distant signaling. Left at 10 a. m., July 21, and anchored in Milford Haven the 22d.

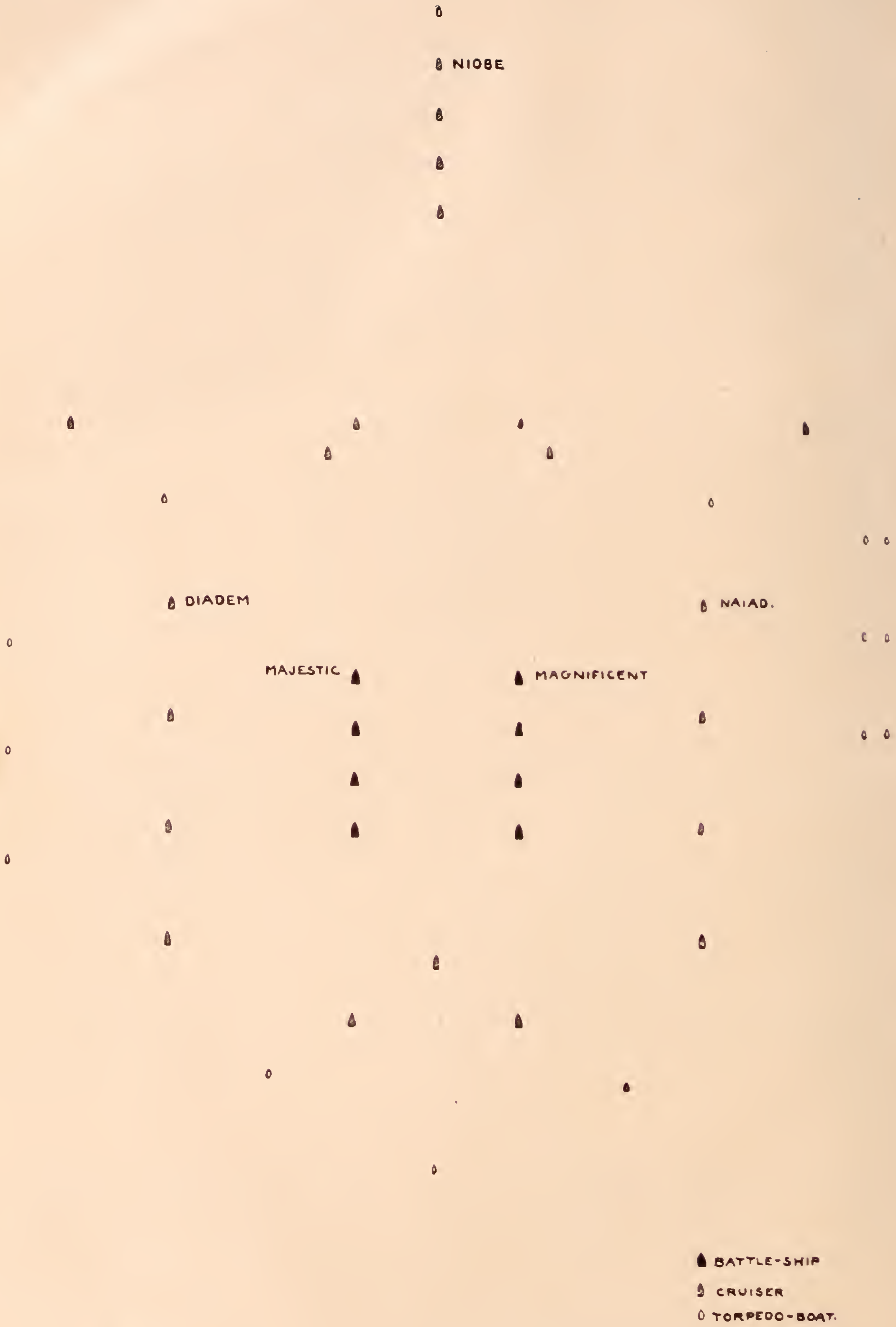
July 17.—Destroyers at Portsmouth underwent a series of evolutions in the Solent. Twenty-one of the torpedo boats in Plymouth Sound went to sea July 16 and exercised at steam tactics and night evolutions in the channel, returning the afternoon of the 17th.

The flotilla of gunboats and torpedo boats carried out evolutions off Plymouth until July 20, when they left for Belfast to join the Channel fleet.

MANŒUVRES—"A" FLEET.

War was officially declared at 10 a. m. Saturday, July 29, and at that hour the leading ship of the A fleet crossed the line drawn from Black Head to Orlock Point, which, according to the rules, defined the protected limit of Belfast Lough. The immediate destination of the fleet was a rendezvous at latitude 55° 52′ N.; longitude 8° 10′ W., some 30 or 40 miles to the northward of Lough Swilly. The fleet passed through the North Channel, which was almost certain to be occupied by some of the enemy's destroyers stationed at Lamlash.

Admiral Rawson was aware that Admiral Domville had received



"A" FLEET. Formation upon departure from Belfast Lough, July 29, 1899 instructions to the effect that his destroyers were to be employed primarily for the attack and destruction of the torpedo boats of the other side, and that the attack of battleships and cruisers by destroyers was only to be regarded as a secondary object. Nevertheless, he thought it prudent to so dispose his fleet as to render an attack by destroyers an exceedingly hazardous undertaking. To this end the battleships were placed in the center of the organization in double column at 8 cables distance, each ship at 2 cables distance. (*See* plate.) On each side a division of 4 cruisers was disposed in column at a distance of 9 cables, each cruiser 5 cables distance, the leading cruiser of each division being on the starboard and port bows of the leading battleships.

Outside the starboard cruiser division 6 torpedo boats were ranged in double column 500 yards apart, intervals being 4½ cables. Outside the port cruiser division 4 torpedo boats were disposed in column at 5 cables distance, each boat being opposite an interval in the cruiser division, the leading boat being on port bow of the leading cruiser. The *Thames* was placed 9 cables astern of the port battleship column and the *Arethusa* the same distance astern of the starboard battleship column, the *Mersey* being 6 cables astern of the interval between the battleship columns with a torpedo boat 10 cables astern of her. On the outboard quarters of the *Thames* and *Arethusa* at 5 cables distance were 2 other torpedo boats. At 12 cables distance ahead of the battleship column were the *Latona* and *Andromeda*, with the *Pique* and *Pelorus* on their outboard quarters. At 10 cables ahead of the interval between the *Latona* and *Andromeda* a third column of cruisers, headed by the *Niobe*, was ranged at 2 cables distance. A torpedo boat led this column.

When Rathlin Island bore abeam, the weather then being thick with a rough sea which made it difficult for the torpedo boats to maintain the prescribed speed of 11 knots, the latter were sent back to Belfast—they had already received instructions as to their future proceedings. At the same time the *Thames*, *Mercury*, and *Arethusa* were dispatched to different signal stations for intelligence with orders to rejoin at a certain rendezvous. The fleet was then changed to a simpler formation and proceeded to the first rendezvous, which was reached at about 9 p. m. The four cruisers which originally formed the van division were dispatched about 8 p. m., as soon as the position was reached at which their share of the combined search was to begin.

PLAN OF SEARCH.

Bearing in mind the leading features of the problem to be solved, it might be anticipated that the place at which the convoy was ordered to wait would be found somewhere within a circle of 300 to 400 miles radius with Fastnet as a center, the latter being the natural landfall of ships making a passage from Halifax to Milford. But there were other conditions involved in the "general idea" and in the "rules and regulations" which made it unlikely that this place would be to the southward of latitude 51° N. A was to be given a certain start and it would seem that in order to reap the benefit of this advantage he should not be obliged to go toward B, but away from him. Again, there would be little or no advantage in this start if the rendezvous were fixed to the southward of latitude 51° N., as within a radius of 350 miles from the Fastnet there is no point that is not nearer to B at Milford than to A at Belfast. As it was not in Admiral Rawson's power to search both areas exhaustively within the time allotted to the manœuvres, he decided to devote his efforts to a thorough search of the northern area. This preference was further fortified by a consideration of the instructions given to Admiral Domville, to the effect that his destroyers were to be employed primarily for the attack and destruction of A's torpedo boats, which would seem to indicate that B would pass through the Irish Channel.

Each battleship and cruiser of the A fleet had been given a prescribed course and speed. The aggregate of these courses covered the whole area of search in such a manner that in ordinary weather no part of it would escape observation. The various courses converged at a point not far from the Porcupine Bank. The scheme was so arranged that the spot where each ship would be at any given time was known to every ship in the squadron—the courses closing in during the night and opening out again after dawn, so that at no hour of the twenty-four could a strange vessel escape observation in clear weather. Each ship was furnished with a chart showing the track of all the others and their positions at the end of each hour. The tracks of the battleships and first-class cruisers were so arranged that a second-class cruiser sighting the convoy would not have to go farther than the time conditions allowed in order to summon assistance from a friendly ship capable of giving battle to the first-class cruiser told off as the convoy's escort. The morning of July 30 the fleet was enveloped in fog, which continued at intervals throughout the day. The *Thames* and *Mersey* joined the flagship from their respective signal stations, but had no intelligence. On the morning of the 31st all the battleships and a portion of the cruisers were at the rendezvous near Porcupine Bank. The *Minerva* was dispatched to Blacksod Bay for further intelligence, and the admiral determined to search again a portion of the area which, owing to fog, had been imperfectly examined the day before, after making arrangements to keep touch with the ships which had not yet completed their share of the original scheme.

The afternoon of August 1 found the battleships all in company at a rendezvous on Rockall Bank waiting for the cruisers to join. At 3 p. m. the *Minerva* arrived from Blacksod Bay with the intelligence transmitted from Queenstown that the B fleet left Milford at 5 a. m. Sunday, steering for the south coast of Ireland, while a detachment of cruisers appeared to be making for the Irish Channel. All of the cruisers employed in the search reported at this rendezvous, excepting the *Diadem*, *Retribution*, and *Pactolus*, which had been assigned the outermost and most southerly tracks of the search. As each cruiser arrived it was dispatched on a new mission to return to a different rendezvous as soon as orders were executed.

This last rendezvous was reached by the flagship *Majestic* on the morning of August 2. The *Diadem* was there, but the *Pactolus* had gone to Kittery Bay to coal and the *Retribution* was missing. Admiral Rawson made the following general signal to the fleet:

> Unless B fleet has had a fog and missed the convoy the game is up, and they are back this evening at Milford. My proper move would therefore be to return quietly to Belfast round the north of Ireland, so as not to give the destroyers a chance. But as I am certain the Admiralty wishes to gain some information as to torpedo boats and destroyers, I have ordered the whole of our torpedo boats to meet the squadron off Waterford, and I shall, with as many cruisers as I can collect, proceed up the Irish Channel to Belfast in the same formation as we left. If B fleet is going back through the North Channel, we shall meet it on the way. If they come out to meet me, I shall let cruisers and torpedo boats at them and try and claim them.

Such was the program for the remainder of the period of hostilities. At 2.30 p. m. August 4, intelligence was received that the B fleet had found the convoy and taken it to Milford, and consequently hostilities were ended. The A fleet then proceeded to Portland.

"B" FLEET.

It was known by Admiral Domville that Admiral Rawson's fleet left Belfast Lough immediately after the declaration of hostilities at 10 a. m. Saturday, July 29. The B fleet was held back until 5 a. m. Sunday, thus giving the A fleet a start of nineteen hours.

The key to the whole situation was the position of the convoy, fixed at latitude 51° 40′ north and longitude 19° west, which fact was not known by Admiral Rawson. The convoy was to remain within a radius of 10 miles from this spot under escort of the cruiser *Galatea*, which had been sent to join it before the declaration of hostilities, until either the A or B fleet fell in with it. Admiral Domville had as his primary object to get to the convoy as quickly as possible, at the same time laying a course so as to avoid observation from the Irish coast.

The manœuvres of the B fleet may be stated briefly as follows:

Confidential instructions were issued to all the captains, designating certain points of concentration:

A. Latitude 50° 36′ north, longitude 9° 37′ west.
B. Latitude 50° 53′ north, longitude 14° 25′ west.
C. Latitude 49° 52′ north, longitude 10° 45′ west.

At 5 a. m. July 30 the *Europa*, *Argonaut*, *Vindictive*, *Gladiator*, *St. George*, *Sappho*, and *Diana* were dispatched to meet the convoy, the *Galatea* being already with the convoy as escort. The remainder of the fleet followed as rapidly as the speed of the battleships would allow. The course to A, the first point of concentration, was to the southward and westward, so as to avoid passing near the coast of Ireland, which was hostile territory and from whence news of his movements could be conveyed to the enemy. The battleships were disposed in single column, with the cruisers and some of the Milford destroyers thrown out around and in advance. The *Juno* kept on a parallel course about 20 miles nearer the Irish coast, with orders to keep a sharp lookout and report any appearance of the enemy. The *Mercury* was left at Milford to bring on dispatches.

Rendezvous A was reached by the fleet shortly before 10 p. m. Sunday. As none of the scouting cruisers were found there, the admiral decided to proceed to rendezvous B, omitting C entirely. The *Forth* was left at A with orders to inform any vessel which might repair there that the fleet had gone to B. This latter rendezvous was reached at 3.15 p. m. July 31. At noon the fleet had slowed to 10 knots to accommodate the *Thunderer*, but at 2.30 the speed was increased to 12 knots, leaving the *Thunderer* to follow as she could. From B the fleet steered direct for the convoy.

About the time the fleet reached B, the fast cruisers sent in advance had found the convoy and started with it toward B. Their junction took place at a point P, latitude 51° 13′ north, longitude 17° 13′ west, at 11.20 p. m. July 31.

At 7.40 p. m. the vice-admiral signaled that the *Juno* had transmitted intelligence from the *Europa* to the effect that the convoy was safe and approaching at 9 knots speed with no signs of the enemy. The total distance covered by the *Europa* and *Juno* seem to have been about 60 miles. The fleet and convoy slowed down to 8 knots, and reached Milford Haven at 11 a. m. August 3, without sighting the enemy.

On the morning of the 3d, the *Europa*, *Argonaut*, *Gladiator*, and *Vindictive*, while scouting ahead of the fleet, captured the *Furious* and *Pactolus* of A fleet.

DESTROYERS AND TORPEDO BOATS.

It is difficult from the meager and conflicting accounts published to arrive at any connection in the operations of the torpedo craft of the two fleets.

On the afternoon of July 27 the torpedo gunboats *Leda* and *Renard*, with their respective flotillas of destroyers, left Milford Haven for their stations at Holyhead and Lamlash to await the opening of hostilities. A third flotilla, with the *Niger* as depot ship, remained at

Milford Haven. Their orders were to patrol and observe but not to remain off the enemy's ports.

The torpedo-boat flotillas, with their depot ships, were stationed at Waterford, Kingston, and Belfast. On leaving Belfast Lough at the outbreak of hostilities, the A fleet was accompanied by both the Belfast and Kingston flotillas. Off Rathlin Island the B destroyers were discovered. One of the latter, sent as a bait to tempt the torpedo boats, was chased by the *Jason* and, it was claimed, put out of action. This claim was disallowed by the board of umpires. In the thick weather encountered at this time the torpedo boats were detached and sent back to Belfast Lough, which they reached in the evening, after being chased by some of the destroyers.

July 30 these torpedo boats were blockaded in Belfast Lough by the Lamlash destroyers. That evening the Kingston flotilla, under cover of a fog, succeeded in running the blockade and reaching their station. They were assisted in this manœuvre by the Belfast fleet, which steamed to the northward to deceive the enemy, and which claimed to have captured three of the destroyers—*Lynx*, *Thrasher*, and *Seal*.

Four torpedo boats of the Waterford flotilla succeeded in eluding the destroyers off Waterford during the night of the 28th and proceeded to Milford to watch B fleet. One of these, *No. 72*, broke down and had to be towed back by *No. 68*, but the other two, *Nos. 73* and *83*, hid off the Welsh coast until 10 a. m. the 30th. They kept the B fleet in sight until afternoon of the same day, when they steamed to Queenstown to report their information to Admiral Rawson.

Early on the morning of the 30th torpedo boat *No. 54* was put out of action by two destroyers while trying to make Waterford.

On the afternoon of the 30th the *Gossamer* with three of her torpedo boats engaged two destroyers off the Hook Lightship, putting both out of action, and later chased and dispersed temporarily the destroyers patrolling the coast.

On the 31st the *Gossamer* succeeded in leaving Waterford, but her torpedo boats were completely blockaded by B destroyers.

August 1 torpedo boat *No. 72* was placed out of action by the *Ferret* in Queenstown Harbor.

The *Haughty* claimed to have captured *Nos. 73* and *83*.

No. 48 was captured off Wexford.

The following telegram was sent out by the Admiralty:

> Claim of *Jason* for one torpedo boat disallowed. *Lightning* and *Hunter* to have captured torpedo boats *63* and *64* allowed. Torpedo boat *83* to have torpedoed *Angler* and *Mallard* out of action disallowed. *Angler* and *Mallard* to have captured torpedo boats *63* and *83* allowed. Torpedo boats *73* and *65* to have torpedoed two destroyers disallowed. *Janus* and another destroyer to have destroyed torpedo boats *74* and *65* allowed. Claim of torpedo boat *46* to have torpedoed *Bat* disallowed. Claim of *Bat* to have captured torpedo boat disallowed.

Spartan.—Returned from steam trials July 12 with defective capstan; repaired at Devonport.

Sappho.—Engine-room defects.

Sybille.—July 31 reported her port engine disabled and could only steam 8 knots with starboard engine.

Pactolus.—August 1 reported bent piston rod and could only steam 13.5 knots.

Retribution.—August 1 reported one engine disabled and could only steam 12.5 knots.

Surprise.—August 5 collided with and sank the steam collier *Netley Abbey* off Portland.

Sans Pareil.—At 11 p. m. August 9 ran into and sank the sailing ship *East Lothian.*

Argonaut and Europa.—Compelled to leave formation on account of leaky pipes and joints; repaired on board.

Haughty, *Lightning*, *and Crane.*—Went into Portsmouth Harbor July 14 to remedy defects developed while manœuvreing.

Teazer.—Developed engine-room defects which necessitated the commissioning of the *Flirt* in her place.

Ferret.—Obliged to return to Portsmouth to remedy engine-room defects.

Gipsy.—July 18, leaky condenser; *Leopard* commissioned in her place.

Janus.—Broke down between Portsmouth and Plymouth.

Fawn.—Damaged her propeller off Calf of Man.

Dasher.—Split high-pressure cylinder head.

Fairy.—Burst boiler tube; repaired at Portsmouth.

Crane and Lightning.—Fouled, due to failure of *Lightning* to answer helm; little damage; repaired at Portsmouth.

Haughty.—Leaky condenser.

No. 65.—Returned to Chatham July 12 with defective feed pump, and put in to Waterford August 3 with defective machinery.

No. 68.—Returned July 12 with a plate stove in from collision, and again on July 15 was sent to dockyard to repair machinery defects.

No. 49.—Steamed to Devonport July 14 with bow stove in, due to collision with *No. 42.*

Nos. 63, 64, 73, 74.—The first three developed defective feed pumps, and *No. 74* broke some stanchions in heavy weather experienced while steaming from Chatham to Devonport; were obliged to put in to Portland for shelter; repaired at Portsmouth. *No. 64* again developed defects on July 16.

Nos. 53, 55, 71, 78.—All developed faulty machinery, principally leaky condensers or leaky joints; repaired at Plymouth.

No. 81.—Returned to Devonport for repairs to boiler.

No. 83.—Minor engine-room defects.

No. 52.—Collided with fishing boat *Leonora;* practically uninjured.

No. 72.—Broke eccentric strap of fan engine; was towed to Queenstown.

No. 76.—Machinery defects; repaired at Devonport.

No. 79.—Defective machinery; repaired at Devonport.

Two lives were lost during the manœuvres. A coal heaver died from heart disease on the *Howe*, and a seaman was caught between the bags and side of a collier while coaling the *Niobe* and instantly killed.

COMMENTS.

The results of the naval manœuvres of this year are in many respects disappointing, and it is difficult to say that they have any positive value or that the objects as set forth by the Admiralty have been attained. This was due in great part to the fog which hampered Admiral Rawson's movements from the start, necessitating a fresh search over waters already investigated. This fact alone doubtless prevented his seizing the convoy either before or soon after the advanced cruisers of B fleet had found it. Had the original plan of scouting to the southward of Porcupine Bank after rendezvousing there been followed, A's cruisers would have undoubtedly picked up the convoy, although Admiral Rawson does not seem to have counted on the convoy's rendezvous being so far to the westward.

The method of scouting and disposition made of the cruisers of B fleet were admirable. A's search, extending over some 70,000 square miles, was so adapted to the alternations of day and night that in ordinary weather no vessel could have escaped observation, and at the end of operations the ships of the fleet were as well in hand as when the search began.

The task set B fleet was comparatively simple, and it proceeded to accomplish its object as if the A fleet did not exist. It is extremely difficult to devise a scheme which will adequately represent the strategic conditions created by powerful fleets in time of war. An examination of the rules will show that the manœuvres were not designed to represent the actual conditions of naval warfare. No real heed was paid to A fleet, and B fleet manœuvred as though she held command of the sea with the sole object of escorting a convoy safely to port.

From the operations of B fleet the principal lesson appears to be the employment and possibilities of wireless telegraphy. The *Juno* was kept usually from 10 to 20 miles ahead of the fleet, to which she transmitted information of fog banks, trawlers' lights at night, and various useful and valuable information. When the message was received that the convoy had been found the flagship was about 30 miles from the *Juno*, 55 miles from the *Europa*, and 86 miles from the convoy.

No attempt was made to coal at sea. Several cruisers of the B fleet had to put into Kittery Bay to coal. The following table gives the coal consumption of B fleet from July 17 to August 8:

	Tons.
10 battleships	8, 091
3 cruisers, (*Europa*, *Argonaut*, *St. George*)	8, 249
1 cruiser (*Galatea*, escort to convoy)	699
16 cruisers, second class	8, 515
28 destroyers	5, 204
3 torpedo gunboats (depot ships)	373
	31, 131

The three first-class cruisers and some of the second-class did a great portion of their steaming at over 17 knots, while the battleships cruised most of the time at about 10 knots, which accounts for the seeming disparity in coal consumption.

The lesson that appears to stand out most strongly as a result of the English manœuvres of 1899 is the extreme frailty and liability to break down of torpedo craft. The superiority of the destroyers over torpedo boats was clearly demonstrated as to seagoing qualities, and, above all, susceptibility to machinery accidents. Of the twenty-four torpedo boats commissioned for the manœuvres, fifteen of them developed machinery defects more or less serious either during the preliminary exercises or the manœuvres proper. Several of them broke down more than once. These defects were doubtless due in great part to the unavoidable delicacy of the machinery of these craft; but they emphasize the fact that torpedo boats, in order to be reliable, must be kept in commission and on the move, or if placed in reserve they should at least have a thoroughly trained engine-room force on board and be given frequent opportunities for exercise—the more the better.

FRANCE.

There were no special naval manœuvres. A number of interesting and instructive exercises were conducted by the Mediterranean Squadron during its cruising, among others the following:

Experiments were conducted to test the visibility at sea of a captive balloon worked from a ship. The balloon was sent up from the *Jauréguiberry*, anchored at Salins d'Hyères, to a height of 1,312 feet. The *Carnot* steamed directly away from the *Jauréguiberry* and attempted to pick up the balloon with her searchlights at stated intervals. It was found that up to 20 miles the balloon was visible, but not beyond that distance. At the close of these experiments the balloon was allowed to ascend to an altitude of 3,500 meters, when, by some accident, the attaching cable broke. The officer in charge, who was making his first ascent, succeeded in bringing the balloon down, anchored it with a special sea anchor, supplied for the purpose, and awaited in safety the arrival of a torpedo boat, which towed the balloon back to port.

During the latter part of July the torpedo boats of the mobile defenses of Corsica were ordered to Toulon for a mobilization with the torpedo boats of the mobile defenses of the latter port. The object of this mobilization was to enable the Corsican boats to benefit by the manœuvres of attack at Toulon and also to exercise with their torpedoes under better advantages than in the waters of Corsica. Rear-Admiral Escande, with a division of guard ships, manned by men of the naval service, anchored at night, with all lights out, somewhere on the coast between La Ciotat on the west and St. Tropez on the east of Toulon. Preparations were made to resist a torpedo attack. Searchlights were not to be used unless an attack was pressed home. The Toulon and Corsican torpedo-boat flotillas left Tamaris Bay to search the coast within the stated limits. The Corsican flotilla discovered the squadron in Lavandon Bay to the east of Cape Benet. Creeping alongshore until near enough to attack, the boats pushed in among the fleet, but only a few succeeded in getting within distance necessary to use torpedoes. No ships appear to have been struck, but a number of torpedo boats were supposed to have been sunk by the fire of the Q. F. guns of the squadron. During the exercises torpedo boat *No. 198* split two tubes and had to be towed into port for repairs.

On August 28 the target practice of the Mediterranean Squadron was held at Médes Rocks from 6 a. m. to 6 p. m. All the heavy and medium guns were used with full charges at ranges varying from 2,200 yards to 4,900 yards. The number of rounds fired was over 1,300, and varied from 100 on the *Neptune* to 36 on some of the third-class cruisers. The following table gives the results:

Ship.	Number of rounds.	Number of hits.	Time.	Percentage.
			Min.	
Brennus	65	30	31	46
Masséna	87	19	18	22
Bouvet	99	32	35	32
Charles Martel	51	28	27	55
Carnot	55	27	22	49
Jauréguiberry	52	32	28	61
Magenta	48	16	27	33
Marceau	95	42	33	44
Neptune	100	42	49	42
Bouvines	47	20	49	42
Jemmapes	24	5	15	21
Amiral Tréhouart	51	30	27	59
Valmy	29	8	25	28
Pothuau	64	29	13	45
Latouche Tréville	40	10	21	25
Chanzy	40	22	22	55
Amiral Charner	40	15	24	37
D'Assas	58	24	17	41
Cassard	51	37	9	72
Du Chayla	57	35	12	61
Friant	60	41	15	68
Davout	32	18	8	56
Galilée	36	21	10	58
Linois	36	22	13	61
Lavoisier	36	13	3	36

Particulars concerning the target have not been published.

GERMANY.

The autumn manœuvres of the fleet began about the middle of August, under Admiral Koster, chief of the naval station in the Baltic. The commander in chief at the manœuvres has hitherto been the admiral commanding the fleet, but now that His Majesty himself is commander in chief of the navy he will appoint the commander at the manœuvres every year.

For tactical purposes the fleet was organized as follows:

Admiral Koster, commander in chief.

First squadron—Vice-Admiral Thomson; Rear-Admiral von Wietersheim, second in command.

First division: First-class battleships *Kurfürst Friedrich Wilhelm* (flagship); *Brandenburg*, *Worth*, *Weissenburg*.

Second division: Third-class battleships *Baden* (flagship), *Bayern*, *Sachsen*.

To this squadron was attached the *Grille* as repeater, and a flotilla of torpedo boats consisting of *D 8* as senior officer's boat and two divisions made up as follows:

Division A: Division boat *D 7*, torpedo boats *Nos. 58, 59, 60, 61, 62, 64*.

Division B: Division boat *D 6*, torpedo boats *Nos. 44, 45, 52, 53, 54, 55*.

Hela, *Greif*, and *Wacht* as scouts.

Second squadron.—Rear-Admiral Hoffman; Rear-Admiral von Bodenhausen second in command.

Third division: Fourth-class coast defense battleships *Hildebrand* (flagship), *Seigfried*, *Beowulf*.

Fourth division: Fourth-class coast defense battleships *Aegir* (flagship), *Oden*, *Frithjof*.

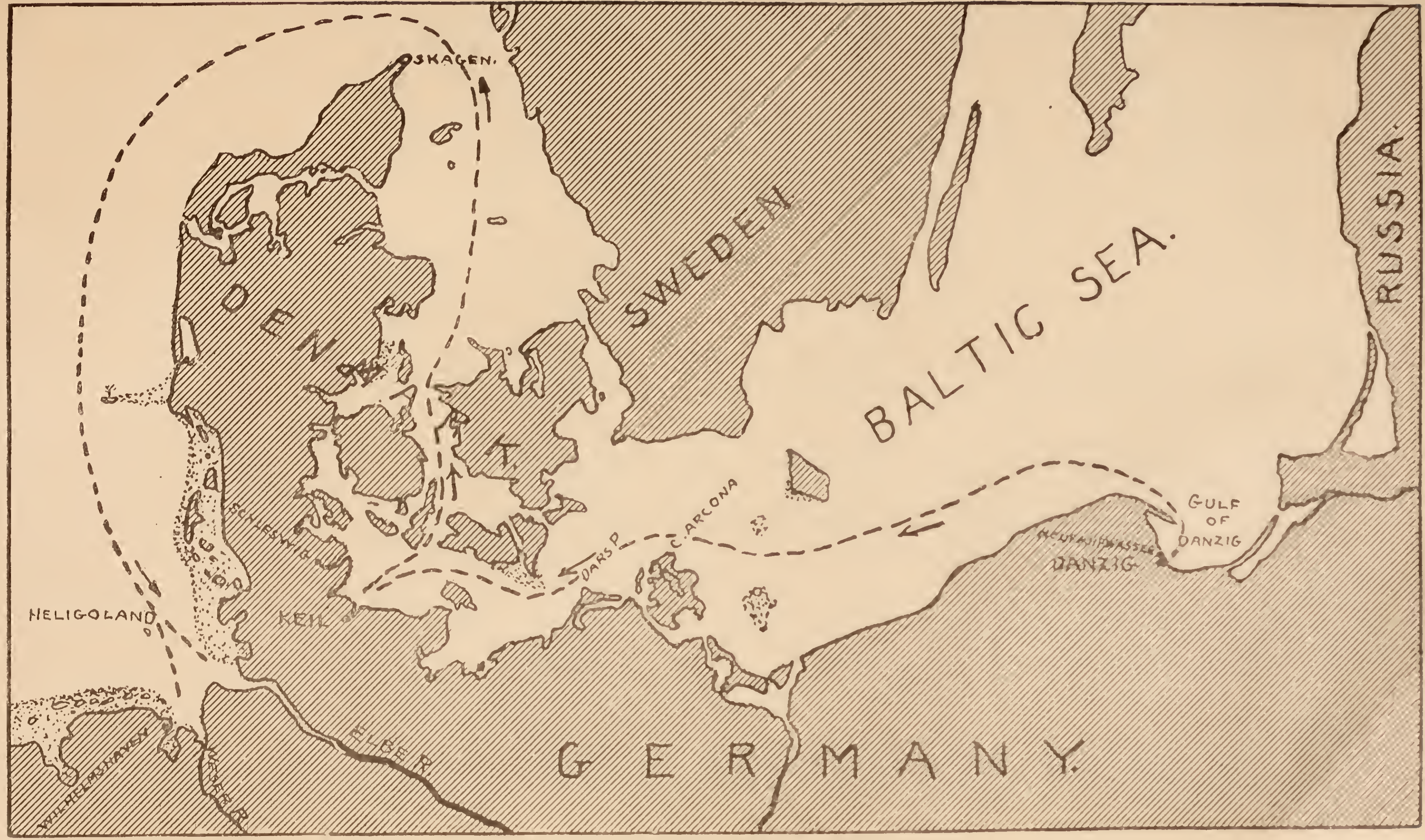
The *Blitz* represented the scouts that should have been attached to this squadron.

Torpedo boat flotilla, composed of *D 5*, as senior officers' boat.

Division C: Division boat *D 10*, torpedo boats *Nos. 82, 83, 84, 85, 86, 89*.

Division D: Division boat *D 2*, torpedo boats *Nos. 76, 77, 78, 79, 80, 81*.

Reserve armored gunboat division: Gunboats *Skorpion* and *Natter*, special-service ship *Pelikan*, fishery cruiser *Zieten*.



SCENE OF OPERATIONS, GERMAN MANŒUVRES.

Description of German ships taking part in the manœuvres of 1899.

Ships.	Displacement.	I. H. P.	Date of launch.	Gun's main battery.	Speed.	Normal coal supply.	Complement.
Third-class cruisers.	*Tons.*				*Knots.*	*Tons.*	
Blücher	2,850	2,990	1877	2	14	400	206
Battleships.							
Kurfürst Friedrich Wilhelm	10,100	9,959	1891	12	16	750	552
Brandenburg	10,100	9,640	1891	12	16.5	750	552
Weissenburg	10,100	9,000	1891	12	16	[1] 750	552
Worth	10,100	10,224	1892	12	16	[1] 750	552
Baden	7,441	6,200	1880 1897	6	17.3	700	376
Bayern	7,441	6,320	1878 1896	6	15.5	700	376
Sachsen	7,441	4,917	1877 1896	6	14	700	376
Coast-defense ships.							
Hildebrand	3,500	4,413	1892	3	16	225	225
Siegfried	3,500	4,800	1889	3	16	[1] 225	225
Beowulf	3,500	4,800	1890	3	16	225	225
Aegir	3,600	4,800	1895	3	17	[1] 225	225
Odin	3,600	4,800	1894	3	16	[1] 225	266
Frithjof	3,500	4,800	1891	3	16	225	225
Dispatch vessels.							
Hela	2,000	5,860	1895	....	20	347	169
Greif	2,000	5,400	1886	....	23	....	130
Third-class cruisers.							
Wacht	1,250	4,000	1887	....	19.6	....	126
Blitz	1,382	2,839	1882	....	16	250	127
Pelikan [2]	2,000	3,000	1890	....	16	....	182
Zieten [3]	975	2,323	1876	....	16	140	111
Grille [4]	350	700	....	....	13	....	74
Armored gunboats.							
Skorpion	1,109	759	1877	1	10	40	76
Natter	1,109	759	1880	1	10	40	76

[1] Also liquid fuel.

[2] Special-service ship.

[3] Fishery cruiser.

[4] Training ship.

TORPEDO FLOTILLA.

No.	Displacement.	I. H. P.	Date of launch.	Speed.	Normal coal supply.	Complement.	Armament.
Division boats.	*Tons.*			*Knots.*	*Tons.*		
D 2	250	1,800	1887	19	50	48	Six 1-pounders; three tubes.
D 5 D 6	320	3,000	1888-1889	22.5	90	48	Four 6-pounders; two 1-pounders; three tubes.
D 7 D 8	350	3,500	1890	22.5	....	....	Six Q. F.: three tubes.
D 10	310	5,800	1898	28.5	80	52	Five 3-pounders; three tubes.
Torpedo boats.							
45 50 to 56 59 to 65	85 to 88	900 to 1,600	1883-1892	20 to 22.5	17	....	Two 1-pounders; two tubes.
74 to 81	125	1,900	1894	25	....	....	Three tubes.
82 to 87	140	2,300	1897-1898	26	32	....	Two 1-pounders; three tubes.
89	160	2,500	1898	26	....	22	Two machine; three tubes.

The fleet assembled in the waters of Danzig Bay on August 16. The 17th, 18th, and 19th were devoted to inspection by the commander in chief, Admiral Koster, in connection with evolutions of the whole squadron and manœuvres of individual ships. Clearing for action exercises were of special interest.

August 20 (Sunday) was given over to boat races between the cutters of the fleet. In this contest there were five groups of six to eight cutters each. The winning boat is allowed to carry a silver spread eagle for one year. This trophy is offered by the Emperor and was won by one of the *Brandenburg's* cutters.

August 21 to 25.—Tactical exercises in the bay of Danzig. The fleet anchored at 6 p. m. each day with the exception of the 25th, when it remained under way for several hours after dark to ward off a torpedo-boat attack. During the previous night these attacks were made against the fleet at anchor. In these exercises rapid fire guns were used with saluting charges.

At the conclusion of these exercises the first squadron anchored in the roadstead of Neufahrwasser, while the second squadron, cruiser, and torpedo-boat flotillas made fast to the piers for the purpose of coaling. The battleships had sufficient coal to take them to Kiel, but the ships of the *Sachsen* class had to renew their supply at Neufahrwasser. A high wind and rough sea made this operation difficult. The first squadron was to have coaled at sea but was unable to do so.

August 27.—The whole fleet started for Kiel, exercising at tactical manœuvres on the way. During the night of the 28th it anchored for a short time at Darsevort, where it warded off another torpedo-boat attack, and arrived at Kiel the afternoon of the 29th.

August 30.—Annual prize target practice of the first squadron; the second squadron and other vessels remaining at anchor. The targets were towed by the scouts. Results said to have been very satisfactory. In this practice, each battleship was allowed only eight shots from their heaviest guns, and as they each have six guns this allowance is only 1⅓ per gun.

August 31.—Coaling at Kiel, five thousand tons were taken by ships and torpedo boats, the *Siegfried* class taking fifty tons in bags on their decks.

September 1.—The fleet started for the North Sea around Cape Skagen, exercising at towing, each ship of the first squadron taking in tow one of the second squadron for several hours. The fleet then anchored in the Great Belt between the islands of Zealand and Funen. The torpedo boats had been sent off at noon with orders to search for and attack the fleet at anchor during the night. About 2 a. m. the torpedo-boat divisions found the fleet. The battleships, using searchlights, rapid fire and machine guns, warded off the attack. The fleet then weighed anchor and continued on its course through the Great Belt. There were no manœuvres on the 2d, as the fleet was to reach Cape Skagen the morning of the 3d.

September 3 and 4.—Strategic exercises. The general idea was that a part of the fleet, consisting of some of the battleships of the first squadron, was to escape through the Skagen Rack unseen, while the other part, composed of the remaining battleships and greater part of the scouting vessels, was to frustrate this manœuvre and force the first part to battle. The *Blücher* was not to take part, but cruise between the two fleets for the purpose of observation. The attempt to escape was made the night of the 3d. The second part succeeded in finding the first but could not compel an engagement.

On the morning of the 4th the whole fleet shaped course for the western coast of Jutland. Battle manœuvres occupied the afternoon and at night the fleet anchored in shallow water in the North Sea.

On the 5th target practice was held near Heligoland. On the 6th the *Blücher* weighed anchor at 7 a. m., giving orders to the battleships of the first squadron to get up full steam in all boilers and join her as soon as possible at a place indicated. The battleship *Weissenburg* was the first to arrive at the rendezvous. The second squadron was to search a certain zone and find the *Blücher*. By 11 a. m. the whole fleet was once more assembled, with the exception of the *Zieten*, which had to go to Wilhelmshafen owing to injuries to her engines.

The fleet then shaped course for Heligoland, where it anchored at 1 p. m. Fleet exercised at fog signaling during fog. At 9 p. m. the ships weighed anchor and put to sea. The torpedo boats, which had been sent out ahead, were to attack the fleet under way. The only information given the latter was that a hostile fleet had started from Heligoland at 9 o'clock, taking a northerly course, so that the torpedo boats were obliged to search for the ships, which proceeded without lights. One torpedo-boat division formed a picket line across the course of the fleet. After several hours' search the ships were sighted and the torpedo boats steamed at full speed for the fleet. Searchlights were used by the ships, but the attack was declared successful; the torpedo boats succeeded in escaping. At the conclusion of this manœuvre the fleet returned to Heligoland, where it anchored the morning of the 7th, and the manœuvres of the week were discussed by the officers on board the flagship. In the afternoon the fleet divided, part of the ships going to Wilhelmshafen and the others to Heligoland for the purpose of coaling.

The closing manœuvres took place from the 10th to the 15th. The first squadron, designated as the "Yellow Squadron," represented the enemy. The second squadron, accompanied by the *Blücher*, represented the German defensive force.

Heretofore the manœuvres have usually occurred in the strategical position at the confluence of the Elbe, Weser, and the Kaiser Wilhelm Canal. This year it was decided to have a somewhat different scheme. The general idea was that a hostile fleet strong in cruisers but weak in battleships goes from Skagen through the Great Belt to blockade Kiel and prevent traffic from the Belt and Baltic Sea to the Kaiser Wilhelm Canal. The German fleet, which is strong in battleships but weak in cruisers, had been detained in the Elbe, and must pass through the Kaiser Wilhelm Canal and meet the hostile fleet to prevent the blockade of Kiel and interruption of traffic. The commander of the "Yellow" fleet had to first ascertain where the German fleet was located and make sure that his line of retreat to Skagen was not cut off.

The usual rules were adopted. Impartial umpires of older retired officers were detailed to each ship. The plans of the commanders of both squadrons were fully submitted to the commander in chief and by him communicated to the umpires, but not revealed to the opposing squadrons.

The difficulties of the three approaches to the Baltic—the Sound, between Sweden and Zealand; the Great Belt, between Zealand and Funen; and the Little Belt, between Funen, Jutland, and Schleswig—made them especially interesting and instructive to both parties. For lack of cruisers the battleships of the *Bayern* class were designated as such, and in order to accumulate a sufficient force the battleships were counted as each being two and under some conditions as four. This was hardly fair in the case of being sought, as four battleships would be found much more readily than one.

A torpedo-boat attack was considered repulsed if the boat was under fire for two minutes before getting near enough to fire her torpedo.

Battleships were regarded as superior to cruisers, and each ship in the squadron was given its comparative value as to the others.

The hostile fleet ascertained during the first forty-eight hours that the approaches to the Baltic were threatened by the German scouts and that the battleships were either in the Elbe or at Kiel. September 11 the *Blücher*, en route to the Great Belt, passed a chain of German torpedo boats thrown out as pickets. The "Yellow" commander sent his scouts through the three channels to the Baltic, while the Germans sought to drive these scouts back and to discover the bulk of the "Yellow" fleet.

The German commander in chief received subsequent orders to remain at Kiel longer than at first intended. About noon August 13 cruisers of both sides were sighted, and it was evident that the stronger force of "Yellow" cruisers was driving the German cruisers down the Belt. In the afternoon, in accordance with information furnished by his scouts, the "Yellow" fleet went on toward Kiel with the intention of blockading the harbor. The German battleships were then leaving Kiel, and "Yellow," being given timely warning by his scouts, turned north and escaped. The German commander, being inferior in speed, was obliged to relinquish pursuit with his squadron, but sent torpedo boats against the hostile ships to attack during the night.

There was no material change in the situation on the 14th. The hostile fleet remained in the northern part of the Great Belt, but as the enemy retreated it had to give up pursuit without having forced "Yellow" to a decisive battle.

Several minor engagements occurred on the 12th. The *Greif*, a German cruiser, discovered the "Yellow" fleet in the Great Belt and started at once at full speed to communicate this fact to his commander at Kiel. The *Greif* turned south through the nearest channel in the islands, but found there a superior "Yellow" cruiser. Another "Yellow" cruiser had been sent in pursuit, and the *Greif* was forced to take refuge in a Danish bay (neutral waters), which, under the rules, was equivalent to out of action.

The "Yellow" fleet anchored on the night of the 14th in a small bay to avoid the German scouts. Soon after the *Kurfurst Freidrich Wilhelm* made out a dark mass on the water close inshore. She at once weighed anchor and proceeded to investigate. Her inquiry remaining unanswered, it was assumed the stranger was an enemy, and the *Kurfurst* simulated a ram attack, which the umpires declared successful. The stranger proved to be the *Bayern*, and was declared out of action. The "Yellow" fleet then got underway and proceeded to another anchorage. The boiler explosion on board the *Wacht* occurred the next morning, and the *Bayern* was designated to tow the damaged cruiser to Kiel.

During the night of the 13th a group of torpedo boats made a successful attack on the *Aegir*, which was declared to have been sunk.

Several other engagements took place between individual ships, in which sometimes the German and sometimes the "Yellow" were successful.

The manœuvres were concluded on the morning of September 15.

The German manœuvres were attended with a number of bad accidents. On board of the cruiser *Wacht*, while returning to the fleet under full steam the morning of September 12, a locomotive boiler exploded killing 4 men and scalding 5 others. The vessel had been put in thorough repair for service only five months previously, and it therefore seems impossible to attribute the cause of the catastrophe to a worn-out condition of the boilers. All the men who might have furnished an explanation were killed.

The *Aegir* sustained a bad collision with an English steamer, and was saved from sinking by heeling over so as to bring the damaged parts above water; this was accomplished by flooding the double-bottom compartment on the opposite side. The ship was skillfully handled when it was seen that a collision was unavoidable, and so placed as to receive the blow upon her armored side rather than where she had no protection. Though badly damaged, she was provisionally repaired at Kiel in time to resume her place in the manœuvres.

The *Hela* and *Zieten* damaged their propellers, necessitating repairs.

The *Bayern* had an accident to her rudder.

The *Odin* had trouble with boilers.

During the heavy weather at the end of August several of the torpedo boats seem to have been damaged. *No. 86* stove her bow in collision and was replaced by *No. 87*. *No. 85* injured her steering gear. *Nos. 51*, *61*, and *63* also suffered damage, and were replaced from the reserve division.

As a whole the operations were largely of the nature of individual practice and tactical manœuvres. Some of the coast defense ships are only in commission for a portion of the year, and were manned partly from the nucleus crews on the "stammschiffe" and partly by reserves. The manœuvres are therefore a period of training for these ships and a test of the practical value of this system at the same time as a part of the general education of the whole fleet. As a training for officers and men, the exercises were exceedingly valuable. It is to be regretted that all details of the manœuvres are lacking and no valuable data published in the various German newspaper accounts.

RUSSIA.

The program for the different Russian fleets mobilized during the present season is exceptionally extensive and interesting. Never in the history of the Imperial Navy have so many squadrons been commissioned for training and special manœuvres.

The Black Sea Fleet, organized as a training squadron, consists of the four battleships *Sinope*, *Drenadsat Apostoloff*, *Tri Sviatitelia*, and *Tchesma*, the torpedo cruisers *Captain Sacken*, *Griedyen*, and *Kazarsky*, and six torpedo boats. This fleet will be engaged in special manœuvres for four months, during three of which it will be accompanied by the battleships *Rostislav*, the *Catherine II*, and *Georgii Pobyedonosetz* acting as reserve.

The Baltic Squadron is composed of the battleships *Poltava*, the armored coast-defense vessels *Admiral Oushakov*, *Admiral Senyavin*, *Apraxine*, and *Admiral Spiridoff*, the torpedo cruiser *Abrek*, and the dispatch boat *Ilmen*, with the destroyer *Sokol* and eleven torpedo boats belonging to the second division. The manœuvres of this squadron were to extend over four months, and the trials were to include prolonged experiments with oil fuel in furnaces constructed on new design and some selected varieties of coal recently mined in the South Russian coal fields.

On the Pacific the Eastern Fleet were to be mobilized for six weeks' manœuvres at sea. This squadron comprises the second-class battleships *Navarin* and *Sisoi Veliki*, first-class armored cruisers *Rossia*, *Rurik*, *Pamyat Azova*, *Dmitri Donskoi*, and *Vladimir Monomach*, second-class cruisers *Admiral Korniloff*, *Zabiyaka*, and *Razboynik*, torpedo cruisers *Vsadnik* and *Guidamak*, and gunboats *Otrajnii*, *Gremiastchy*, *Koretz*, *Mandjour*, *Sivoutch*, and *Bobr*. A special torpedo-boat flotilla has been organized this season for the first time as the East Siberian Torpedo Squadron, which includes boats *Nos. 201*, *202*, *208*, *209*, *210*, and *211*, with *Nos. 203*, *204*, *206*, and *207* stationed at Port Arthur.

A special naval artillery training squadron was organized for a four months' cruise and for practice with the improved guns about to be adopted in vessels under construction. This squadron comprised the *General Admiral*, the coast monitors *Pervenech*, *Kreml*, *Admiral Greig*, the torpedo cruiser *Woewoda*, and two torpedo boats.

A torpedo training-school squadron was arranged for four months' special work, and was composed of the cruiser *Afrika*, torpedo cruiser *Lieutenant Ilyine*, torpedo depot ship *Europa*, training ship *Dwina*, three torpedo vessels, and four torpedo boats. A torpedo of a new form, the invention of a Russian naval officer, was to be made the subject of experiments during the exercises of the squadron.

A training squadron for naval cadets, commissioned for three months, comprised the first-class cruiser *Kniaz Pojarski*, second-class cruisers *Rynda* and *Asia*, and training ships *Vierny* and *Moriak*.

Lastly, a scientific squadron organized as an engineer training flotilla was commissioned for four months, comprising the coast-defense battleship *Natron Menia*, torpedo boats *Nos. 16* and *49*, and two special vessels constructed for experiments with patent fuel. The possibilities of oil as a fuel under all sorts of varying conditions were to be thoroughly investigated and reported.

IX.

EMBARKATION OF BRITISH TROOPS FOR SOUTH AFRICA.

By Lieut. W. L. Howard, United States Navy, *Staff Intelligence Officer.*

Great Britain, to a greater extent than any other power, is constantly engaged in the transportation of troops to and from her distant colonial possessions. Her transportation system is the product of vast experience, and only a well-nigh perfect system of organization, coupled with the fact that command of the sea is undisputed, could make practicable the present prompt departure of troops for South Africa.

The whole of the trooping arrangements are in the hands of the Admiralty, which contains a separate department under charge of a naval officer of high rank who is styled director of transports. He is responsible for the organization and detail of all sea transportation, and must be constantly prepared for a sudden call for the transport of a battalion of infantry to an army corps.

Experience has condemned the practice of maintaining a number of "troopers," ships built specially for the purpose of carrying troops, for in time of war the crews would be required for the fleet and in time of peace the system is costly. Again, in time of war it has always been necessary to resort to hired transports, and as an example of the difference between the old "trooper" and a modern vessel when fitted for transport service, the *Jumna*, of 6,211 tons, carried, roughly, 1,100 men, while the *Kildonan Castle*,[1] of 9,664 tons, chartered for the present war, it is stated, can carry 2,700 men and 150 officers, and that too, at about 40 per cent greater speed. These vessels when engaged are divided into three different classes, officially designated as transports, troop freight ships, or store freight ships, according to the terms of contract. Transports are vessels wholly engaged by the Government for a specified time and specified service, and while on such service temporarily lose their identity. Thus the *Nubia* is officially designated *Transport No. 4*, the *Pavonia*, *No. 18*, etc. A troop freight ship is a vessel partially engaged for the conveyance of troops. Store freight ships are vessels wholly or partially engaged for Government freight.

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[1] This transport sailed November 4 with 2,341 officers and men, and in addition to their arms and equipment carried 5,000 revolvers and 500,000 rounds of small-arm ammunition.

The transports have all to be fitted and inpsected according to specifications prepared by the Admiralty, the details of accommodations being worked out with extreme care. The space allowed to each individual is in strict accord with sanitary requirements, and sickness seldom, if ever, occurs which can be traced to overcrowding.

In arriving at the number of ships necessary to transport a considerable body of troops the calculation is ordinarily based upon gross tonnage. In a short voyage 1½ tons per man and 5 tons per horse is considered a sufficient allowance, but in long voyages more space must be allowed. In 1879 a force of 8,136 of all ranks, with 1,851 horses, was transported from Great Britain to the Cape in 18 steamers with a total of 55,000 tons. In 1882 a force of 19,148 of all ranks, with 5,908 horses, was conveyed to Egypt in 47 steamers with a total of 140,000 tons.

The personnel of a British army corps consists approximately of 35,000 men of all ranks. With this corps there will have to be dispatched a force to guard the lines of communication, the war establishment of which is approximately 4,500 men. As a matter of fact, the following numbers composed the First Army Corps, the excess being cavalry:

Men	41, 375
Horses	12, 570
Wagons	936

It was calculated that to transport this body to the Cape, with stores and equipment, would require 330,000 tons of shipping, apportioned as follows:

	Tons.
Officers and men	125, 500
Horses	49, 210
Guns and wagons	2, 808
Baggage	10, 344
Ammunition	1, 161
Consumable stores	15, 863
General-service stores	125, 125
Total	330, 011

The following particulars of 16 typical ships which were dispatched will indicate the capabilities of merchant ships to act as transports:

Steamships.	Tons.	Officers.	Men.	Horses.
Roslin Castle	4,487	80	1,004	6
Yorkshire	4,316	32	1,103	6
Harlech Castle	3,264	28	700	....
Lismore Castle	3,529	20	990	6
Manila	4,210	22	1,000	6
Nubia	5,904	62	1,606	6
Gascon	6,288	160	1,520	6
Goorkha	6,207	160	1,520	6
Malta	6,064	75	1,587	6
Pavonia	5,588	90	1,504	6
Oriental	5,284	75	1,218	6
Hawarden Castle	4,380	80	1,004	6
Aurania	7,269	150	1,704	6
Armenian	8,835	36	733	658
Nomadic	5,749	6	60	614
America	5,159	16	350	170
Total (16 ships)	86,533	1,094	17,603	1,620

An average of 5,468 tons, 68 officers, 1,100 men, and 101 horses per ship.

With the selection and preparation of the ships as transports the war office has nothing whatever to do beyond appointing the military members of a mixed board which passes the ships for use. The transport department of the Admiralty is responsible for every detail connected with the transportation of troops from water's edge to water's edge at the ports of embarkation and disembarkation, respectively. But the military authorities are responsible for the amount of space and accommodation required and for putting details on board and on shore in an orderly manner.

At each of the main points of embarkation a number of naval officers are stationed, the senior being assigned as principal transport officer. In addition to these, each transport has assigned to it a naval officer who is responsible for the proper fitting out of the ship, its readiness to receive troops with assigned stores and equipments at the prescribed times, and for the stowage of men and material.

The troop officers are quartered in the usual passenger quarters of the ship, and if this is not sufficient, additional two-berth rooms are built wherever most convenient. All the enlisted force are berthed in hammocks provided by the Admiralty, fitted with clews and heavy blankets, but no mattresses. Heavy stringers are run along the decks of a transport under the overhead beams, with thwartship scantling at intervals, into which hammock hooks are screwed at 14 inches space. This framing is covered with light batten strips, thus giving ample stowage space for each soldier's kit and cork life belt, the latter being stowed in place before the troops arrive. In each compartment of the deck is a large bin with several sections, in which the hammocks are stowed, rolled lengthwise with blankets inside and the clews tied around, instead of lashed as is customary in the Navy. The only fixed berths provided are in the sick bay, where double-tiered iron standing berths are fitted with mattresses and pillows. About 2 per cent of the number of troops carried is the allowance for sick-bay berths, and a small detached bay is provided for infectious cases. A commodious bathroom is attached to each sick bay. The dispensary is separate.

On each deck standing mess tables with benches are fitted to accommodate the men berthed on the deck. The tables are in a row along the sides, leaving the midship part of the deck clear. They extend inboard from the ship's side, where they are rabbeted or hung over a stringer and, with the benches, are securely nailed to the deck.

The regulations give the following as a rough rule for the number of men a given space will take: Two and a half men to each foot of length when the beam allows 6-foot mess tables to be used; 3 men to each foot of length when the beam allows 7-foot 6-inch tables to be used; 3½ men to each foot of length when the beam allows 9-foot tables to be used; 6-foot tables take 8 men; 7-foot 6-inch tables 10 men, and 9-foot tables 12 men each. By special authority, two more men can be added to each table. When the beam permits, the 9-foot tables for 12 men each are the best to fit.

Tables are to be 5 feet 6 inches from center to center on decks with side lights, but 6 feet 6 inches on decks not so provided.

There should be a clear 2 feet 6 inches from end of tables to coamings of hatchways, etc.

Over each table is painted on the ship's side the number of the mess to occupy it and the number of men in the mess.

In suitable compartments below are built the armories, where rifles and carbines are stowed horizontally in tiers, each rifle resting in scores cut to receive it; revolvers stowed in pistol racks and sabres in vertical stands. A compartment or large bin is fitted with partitioned shelves for the knapsacks of the men of each unit separately. A compartment is also fitted with rows and tiers of small open-faced boxes to hold the helmets with which all the troops are provided.

Transports for mounted troops are fitted with a compartment for horse trappings, vertical stanchions with long upward-sloping pegs for saddles and bridles, and horizontal baize-covered poles for hanging harness. In some instances this gear arrives all bagged and marked with unit and horse to which it belongs, in which case it is simply stowed in the compartment provided.

Bakeries, galleys, guard and orderly rooms, magazines, wash rooms and latrines, are fitted on all transports according to Admiralty specifications and entirely independent of the ship's usual furniture. The wash rooms are fitted with running water and metal tipping basins which empty into ample overboard pipes.

The horse transports are generally ships that are used in the live-cattle trade. The horse decks are above the water line. The decks are laid in cement, with heavy rounded fore and aft wooden strips for the animals to brace their feet. For the conveyance of horses the Admiralty require that there must be a 2-foot passage between the ship's side and the cant at the rear of the stalls, while each stall must be of the following dimensions:

	Ft.	in.
Length from breast to haunch in the clear	6	0
Breadth between parting bars in the clear	2	2
Height of parting bar from platform to top	3	9
Height of breast rail from platform to top	3	9
Height of haunch rail from platform to top	3	6
Boards fitted as kicking boards (one pair for every 10 stalls):		
Length	6	9
Breadth	1	6
Thickness		1½

In addition to these what we may term ordinary stalls, "large stalls" are to be provided for 5 per cent more horses than the number to be embarked, and 5 per cent of the stalls are to be 6 inches longer and 2 inches wider than the others. In addition to these larger stalls, which should be together, and clearly marked "large stalls," loose boxes are to be provided amidships on each deck or compartment on which horses are carried; and when possible, one is to be built on the upper deck for each 50 horses provided for.

Each stall is supplied with a pair of canvas cushions for the top rails on each side of a horse in case of heavy weather.

The heavy wagons of the field telegraph company, bridging battalion, field hospital, etc., are stowed loaded, with covers on, on top of other cargo, so that no weights come on top of them. The wheels are taken off. Only a portion of special wagons of the army service corps are being taken, as it is the intention to use the wagons of the Cape, as better suited to the country for transport purposes.

The guns and wagons of the artillery batteries and ammunition columns are stowed in the holds with wheels on and wagons loaded; cartridges and fused shell in the magazines. The guns and caissons have stout wooden frames over the breech of the gun, covering projecting fittings. All guns, wheels, etc., are painted a uniform khaki color.

The transport arrangements are admirable. The day previous to the embarkation of a certain unit, an advance party arrives at the ship from the camp or barracks with the heavy luggage, which they see stowed, and learn the interior arrangements of the ship. The military chief transport officer at each principal point of embarkation arranges the times at which the units should arrive alongside a designated transport. He has a number of officers of the district and noncommissoned officers as assistants. Each of these officers, as also each of the naval transport officers, is provided with a sheet showing the number of each train to arrive, time of arrival, the unit on board and name of commanding officer, the number of men comprising the unit, and the number of transport on which it is to be embarked. The naval transport officer of the ship arranges what compartments the unit is to occupy, the number of mess tables assigned to it, and has the advance party ready to assist.

Each troop train carries in a conspicuous place a number corresponding to its number on the transport sheets, and in the case of Southampton is switched from the main line into the docks and the shed alongside its assigned transport. During the railway passage bayonets are fixed with scabbard on, and all straps, belts, etc., stowed in knapsacks. As soon as the men leave the car they are formed in column of companies by their officers, and under direction of the staff officer are marched to the proper gangways, where is formed a passing line from the dock down to knapsack and helmet rooms. This line is formed from the advance party under the supervision of the naval transport officer. The arriving troops ground arms, unsling knapsacks, and standing in company front pass knapsacks, then helmets, from one to the other to the passing line, and so on down to the storerooms, where they are stowed according to companies. The passing line then shifts to the armory and the rifles are passed and stowed in the same way. No ammunition is carried by the men, but an ample supply in packing cases accompanies each unit, stowed in the magazines provided for it.

The noncommissioned officers of each company are then called to the front, the company divided into groups according to capacity of mess tables, each group placed in charge of a noncommissioned officer who is given the number of his mess and directed to march his detachment on board and stow their sea-kit bags and overcoats in the battens over the mess table. At the gangway each group is met by an assistant and piloted to their table. So methodically and rapidly is this system worked out that a battalion of over 1,000 men have arrived and been placed on board with all accouterments stowed in place in but little over an hour.

Southampton is an ideal place to embark troops so far as relates to docking. The dock frontage is sufficient for thirty-six large transports to lie alongside and load, while the dock fronts are covered with great sheds, into which trains from the main line can be switched. Twenty-one thousand officers and men, 1,600 horses, and seven batteries of artillery, together with wagons, stores, and field equipment, were embarked between the 20th and 24th of October from these docks. Complete infantry brigades with their auxiliary trains sailed on the 20th, 21st, and 22d, 5,000 men going out on the 20th, about 6,000 on the 21st, and about 4,000 on the 22d.

The following table gives a complete list of vessels and tonnage chartered by the Government up to December 20:

Name.	Tons.	Name.	Tons.
Malta	6,064	Hambleton	3,024
Nubia	5,904	Manchester Port	5,658
Simla	5,884	Manchester Importer	4,028
Oriental	5,284	Eversley	2,866
Omrah	8,291	Idaho	5,971
Kinfauns Castle	9,664	Rapidan	7,359
Kildonan Castle	9. 664	British Princess	7,326
Braemar Castle	6,266	Anubis	2,406
Roslin Castle	4, 487	Mohawk	4,212
Aurania	7,269	Canning	5,366
Cephalonia	5,606	Mab	2,833
Sylvania	5,598	Trevanion	2,437
Dilwara	5,441	Brookside	2,705
Duneva	5,413	Caspian	3,603
Avoca	5,324	Englishman	6,336
Jelunga	5,186	Anselma de Larrinaga	4,094
Zayathla	4,203	Devonia	4,270
Zibenghia	4. 163	Meath	2,295
India	4,074	White Jacket	2,237
Warora	3,980	City of Rome	8,000
Lindula	3,346	Sardinian	4,405
Wardha	3. 976	Tokio	3,827
Vadala	3. 334	Glengyle	3,455
Ellora	1,996	Bombay	3,192
Gascon	6,288	Scot	7,815
Goorkha	6,207	Greek	4,747
Mexican	4,549	Goth	4,738
Algeria	4,510	Monterey	5,455
Montezuma	8,000	Atlantian	7,354
Mount Royal	7,045	Majestic	9,984
Monarch	7,296	Victorian	8,825
Bavarian	10,000	Ocampo	2,052
Sicilian	5,380	Sumatra	4,607
Nomadic	5,749	Sutlej	4,164
Britannia	5,004	Formosa	4,045
Columbian	5,614	Manila	4,210
Antillian	5,608	Orient	5,365
Ranee	5,750	Hawarden Castle	4,380
Nurami	4,432	Lismore Castle	3,529
Orcana	4,803	Harlech Castle	3,264
Hyades	3,400	Servia	7,392
Cheshire	5,708	Carinthia	5,598
Langton Grange	9,200	Pavonia	5,588
Denton Grange	5,742	Catalonia	4,841
Southern Cross	5,050	Virawa	3,333
City of Cambridge	3,788	Lahore	3,269
City of Vienna	4,672	Nowshera	3,024
Nona	2,242	Putiala	2,998
Hurona	3,432	Nevasa	2,998

Name.	Tons.	Name.	Tons.
Pabitana	2,998	Magda	2,350
Booldana	2,860	Manchester City	5,833
Sirdhana	2,829	Manchester Corporation	5,367
Secundra	2,616	America	5,159
Sirst	2,610	Pindari	5,674
Henzada	2,078	Bhamo	3,127
German	6,763	Chicago	6,408
Gaika	3,975	Tabor	2,406
Trojan	3,471	Maine[2]	2,816
Spartan	3,403	Cervantes	4,640
Persia	5,000	Penarth	3,035
Arawa	5,060	Graphic	2,490
Prah	2,520	Wakool	5,014
Mohawk	5,658	Corinthia	1,330
Montfort	5,481	Dictator	4,116
Mongolian	4,909	Ismore	6,215
Siberian	3,846	Templemore	6,276
Medic[1]	12,000	Elton	2,461
Jamaican	4,502	Upada	5,257
Barbadian	4,502	Rajah	5,750
Nairung	4,425	Lawada	3,269
Armenian	8,835	Florida	3,202
Herminius	3,525	Gloxinia	2,540
Hellopes	2,774	Iona	3,344
Yorkshire	4,316	Europe	5,302
Urmston Grange	3,444	City of Lincoln	3,182
Florence	2,492	Narrung	5,078
City of Venice	4,672	Buluwayo	4,412
City of London	3,229	Maplemore	7,717
Kelvin Grove	3,163	Ruahine	6,127
Devona	3,779		

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[1] Chartered by Victorian government.

[2] Loaned by owners for hospital ship.

Total, 159 ships, 757,001 tons.

X.

WIRELESS TELEGRAPHY.

By Lieut. W. L. Howard, United States Navy, *Staff Intelligence Officer.*

Ethereal telegraphy is by no means new, but now that it has become an established fact it has unquestionably a great field before it. Wireless telegraphy will not take the place of telegraphy with wire. Each has a special field of its own and under conditions which the other can not readily fulfill.

In 1884 it was noticed that ordinary telegraphic messages sent through insulated wires buried in iron pipes under the streets of London were read upon telephone circuits erected upon poles carried above the housetops, in some instances over 80 feet away. Upon investigating this phenomenon, Mr. W. H. Preece found in the following year that ordinary telegraphic circuits produced disturbances in instruments situated 2,000 feet away, and in 1886 and 1887 careful experiments showed that these effects were due to electro-magnetic wave currents, and were entirely free from earth conduction. In 1892 these experiments had advanced so far as to admit of distinct messages being sent across a portion of the Bristol Channel, namely, between Penarth and Flatholm, a distance of 3.3 miles; but it was not until 1895 that anything practical was accomplished. In that year the cable between Oban and the Isle of Mull broke down, and as no ship was available for repairing the cable and restoring communication the expedient was adopted of establishing parallel wires on each side of the channel and transmitting signals across the space by electro-magnetic waves.

This brings us to the first of the two practical systems of ethereal telegraphy—the Preece system of induced currents over approximately horizontal and parallel wires. In this system two parallel circuits are established, as, for example, on each side of a channel or bank of a river, each circuit becoming successively the primary and secondary of an induction system, according to the direction in which the signals are being sent. Strong alternating or vibrating currents of electricity are transmitted in the first circuit so as to form signals, letters, and words in Morse character. The effects of the rise and fall of these currents are transmitted as electro-magnetic waves through the intervening space, and if the secondary circuit is so situated as to be washed by these ethereal waves their energy is transformed into secondary currents in the second circuit, which can be made to effect a telephone and thus to reproduce the signals. Their intensity is much reduced, but their presence has been detected through 5 miles of clear space.

The apparatus used in communicating between Oban and the Isle of Mull consisted of (see sketch)—

A rheotome, or make-and-break wheel, causing about 260 undulations per second in the primary wire;

An ordinary battery of about 100 Leclanché cells, of the so-called dry and portable form;

A Morse telegraph key;

A telephone to act as receiver; and

A switch to start and stop the rheotome.

Good signals depend more on the rapid rise and fall of the primary current than on the amount of energy thrown into vibration. Leclanché cells gave as good signals at 3.3 miles distance as 2½ horsepower transformed into alternating currents by an alternator. Two hundred and sixty vibrations per second give a pleasant note to the ear, easily read when broken up by the key into dots and dashes.

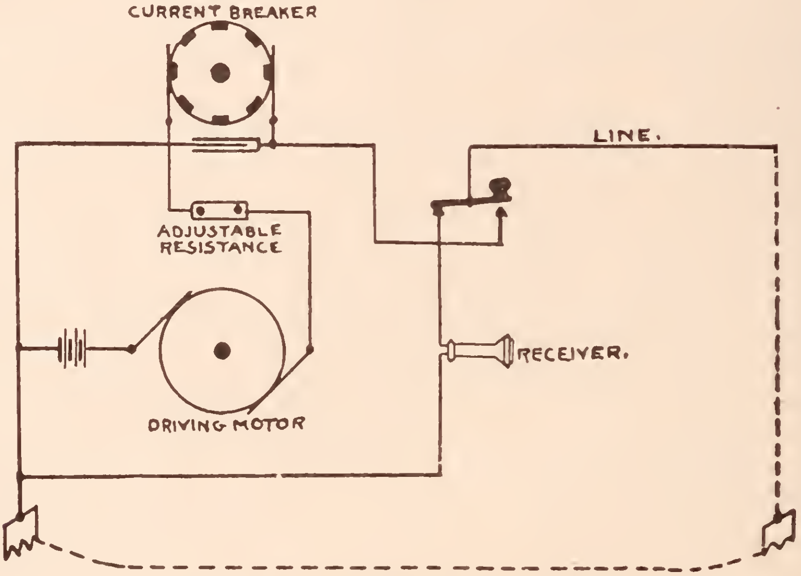

DIAGRAM OF CONNECTIONS OF MR PREECE'S SYSTEM.

This system is at present in operation in the Bristol Channel between the mainland and two small islands, Flatholm and Steepholm, distances of 3½ and 4½ miles, great lengths of wire being stretched parallel to each other along the islands and mainland. To communicate by this system there must be a length on each side of parallel wire equal to the distance to be bridged.

It is the opinion of Prof. Oliver Lodge that no great distances can be attained by methods of simple induction, such as this, without the expenditure of an enormous and disproportionate amount of electric force and the use of great lengths of wire. He proposes and has conducted a series of successful experiments by which communication is established through "electrically similar" circuits. His account of his first experiments in Liverpool is as follows:

> I have at my house a cable a quarter of a mile long altogether, inclosing an elongated rectangle, say 150 by 30 yards; and with that I can hear all that goes on in the neighboring telephone wires, and can even answer back with a suitable microphone transmitter, and can hear the signals when they are being sent to me from an equal length of cable round an equal but squarer contour at the Liverpool College, about 2 miles away.

The important point here is that where, in Mr. Preece's induction experiments the length of the parallel wires had roughly to be the same as that across which signals were sent, Dr. Lodge's syntonic circuits were only a quarter of that length and might have been still further reduced. Experiments along these lines are still in progress, the latest form being the use of vertical coils of wire instead of horizontal circuits.

THE MARCONI SYSTEM.

Dr. Heinrich Hertz, professor of physics in the University of Bonn, was the first to discover that high frequency electric waves could be propagated, reflected, and deflected, while Mr. Edward Branly, in France, was among the first to improve on the delicate form of detector of these waves, which is called a coherer. Roughly speaking, if a vacuum tube is filled with iron filings the tube may be regarded as a nonconductor; but if a discharge of high frequency electric waves takes place in its neighborhood, the filings instantly cohere and the tube becomes a conductor. The slightest shake or tap brings the tube back to its normal condition. Among the students who experimented along these lines has been Mr. G. Marconi, who has made several improvements in the form of the coherer as well as in the form of the apparatus for transmitting the waves, and who has really been the first to adapt these signals to the purposes of systematic commercial telegraphy.

The following brief description of the apparatus used by Mr. Marconi is taken from a paper read by him before the Institution of Electrical Engineers:

> *Transmitter.*—When long distances are to be bridged over and it is not necessary that the signals should be sent in a definite direction, an arrangement such as shown in fig. 1 is used. Two small spheres connected to the terminals of a secondary winding of an induction coil *c* are connected, one to earth and the other to a vertical conductor *w*.
>
> The transmitter works as follows: When the key *b* is pressed, the current of the battery is allowed to actuate the spark coil *c*, which charges the spheres of the vertical wire *w*, which discharges through the spark gap. This discharge is an oscillating one, and the system of spheres and insulated conductor becomes a radiator of electric waves. It will be readily understood that by pressing the key for long or short intervals it is possible to emit a long or short succession of waves, which, when

they influence the receiver, reproduce on it a long or short effect, according to their duration, in this way reproducing the Morse or other signals transmitted from the sending station.

The coherer used is one designed by Mr. Marconi. It consists of a small glass tube *s*, 4 centimeters long, into which two metal pole pieces *j j* are tightly fitted. They are separated from each other by a small gap, which is partly filled with a mixture of nickel and silver filings. This coherer forms part of a circuit containing the local cell and a sensitive telegraph relay actuating another circuit, which circuit works a trembler *p*, or decoherer, and a recording instrument *h*.

In its normal condition the resistance of the filings in the tube *s* is infinite, or at least very great, but when the filings are influenced by electric waves or surgings cohesion takes place instantly and the tube becomes a comparatively good conductor, its resistance falling to between 100 and 500 ohms. This allows the current from the local cell *g* to actuate the relay *n*.

One end of the tube is connected to earth and the other to a vertical conductor similar to that of the transmitter, fig. 1. All the electro-magnetic apparatus in the receiver is shunted by non-inductive resistances in such a manner that there may be no sparking at contacts and no sudden perturbations or jerks caused by the local battery current near the coherer. It was found that the relay tapper and telegraphic instrument if not properly shunted produced disturbing effects, the result of which was to prevent the coherer from regaining its sensitive condition after the receipt of electrical oscillations. No such trouble was experienced when suitable shunts were used, and Mr. Marconi attributes to their action in very great measure the success he has attained with this system.

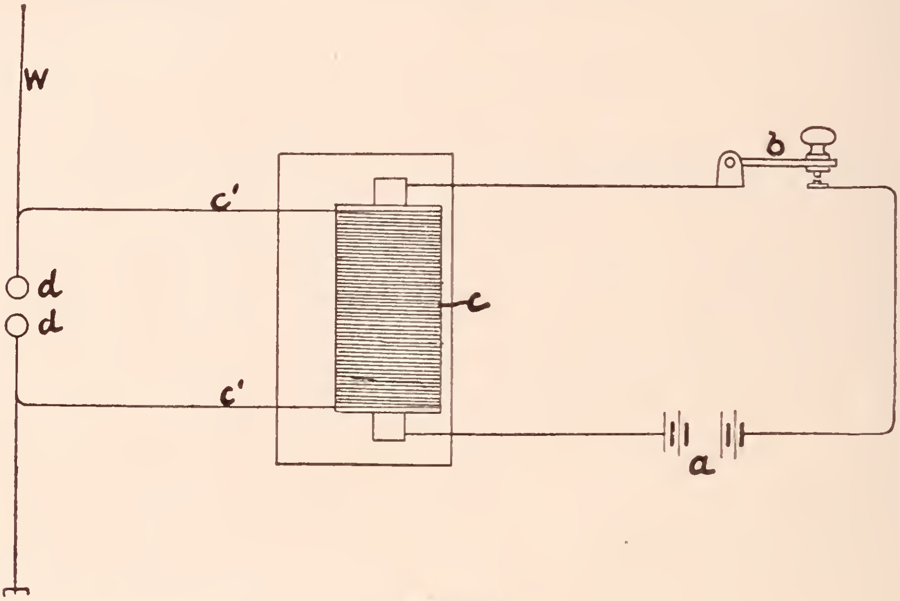

FIG. 1.

Small choking coils *k' k'* are introduced between the coherer and the relay. They compel the oscillating current due to the electric waves to traverse the coherer rather than waste its energy in the alternative path afforded by the relay.

The oscillations induced on the aerial conductor *w*, which acts as resonator, by the radiation from the oscillator, affect the sensitive tube. This effect on the tube consists, as has been shown, in a great increase of its conductivity, thus completing the circuit and allowing the current from the cell to actuate the relay. The relay in its turn causes a larger battery *r* to pass a current through the tapper or interrupter *p*, and also through the electro-magnets of the recording instrument *h*.

The tapper or trembler is so adjusted as to tap the tube and shake the filings in it. If in the instant during which these various actions take place the electrical oscillations ceased in the resonator, the shake or tap given to the tube by the hammer *o* would have restored it to its normal condition of high resistance and the Morse instrument or recorder would have marked a dot on the tape; but if the oscillations continue at very brief intervals the acquired conductivity of the tube *s* is destroyed only for an instant by the tap of the trembler and immediately reestablished by the electrical surgings, and therefore the relay tapper and telegraph instrument are again actuated, and so on until the oscillations from the radiator cease.

The practical result is that the receiver is actuated for a time equal to that during which the key is pressed at the transmitting station. For each signal, however short, the armatures of the relay and tapper perform some very rapid vibrations dependent on each other. For it is the action of the relay which starts the tapper, but the latter by its action interrupts the relay.

The armature of the Morse recording instrument, being rather heavy and possessing a comparatively large inertia, can not follow the very rapid vibrations of the tongue of the relay, but remains down all the time during which the rapidly intermittent action of the receiver lasts. In this way the armature of the inker gives a practically exact reproduction of the movements of the key at the transmitting end, dashes coming out as dashes and dots as dots.

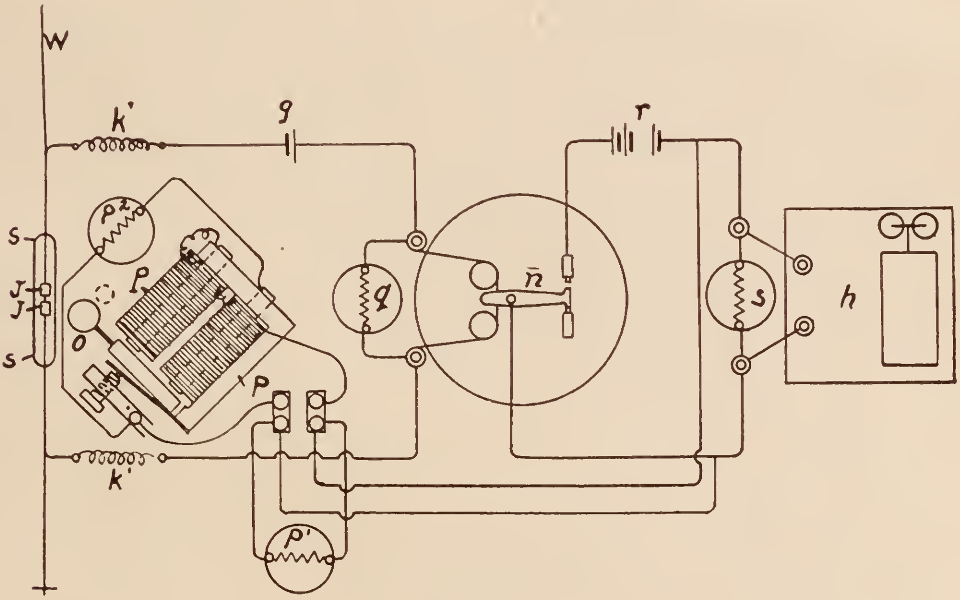

FIG. 2

The foregoing is a general description of the principal apparatus used by Mr. Marconi in his system of wireless telegraphy. It is impracticable to give the many improvements that have been made in the instruments themselves—and are still being made—or to enter into technical details. The principle remains the same, and while the system is far beyond the experimental stage, it is as yet in its infancy and new results are constantly developing and perfecting its application.

Mr. Marconi has proved by experiment that up to certain limits, given a parity of conditions, the distance to which effective signaling extends varies approximately as the square of the height of the rod. A vertical wire 20 feet long at the transmitter and receiver is sufficient for communicating one mile, 40 feet at each end for four miles, 80 feet for 16 miles, and so on. Theoretically, there seems to be no limit to its range, given sparks powerful enough and conductors high enough. Practically, however, there are numerous obstacles. It may be of interest to note the practical results accomplished by the Marconi system up to date.

In November, 1897, a station at Alum Bay, Isle of Wight, and another at Bournemouth, 14½ miles distant, were erected for the purpose of testing the practicability of the system under all conditions of weather. At each station a pole 120 feet high was used to support the aerial conductor. The first tests were made between the Isle of Wight and a steamer with a mast 60 feet high. Readable signals were obtained up to a distance of 18 miles from Alum Bay. In September the Bournemouth station was transferred to Pool, increasing the distance between the stations to 18 miles. Experiments and tests were carried out daily between the two stations, improvements in apparatus allowing a reduction in the height to 80 feet at one end. An average of 1,000 words were daily transmitted each way with the experience that there was no condition of weather which could stop or seriously interfere with the working of such an installation.

In July, 1898, the Daily Express, of Dublin, arranged to have the results and incidents of the Kingstown regatta reported by wireless telegraphy from a steamer chartered to follow the racing yachts. A pole 110 feet high was erected at Kingstown in the grounds of the harbor master, from whence telephonic connection was established with the Express office in Dublin. A steamer, the *Flying Huntress*, was fitted up with the necessary instruments in the cabin. The height of the steamer's vertical wire was 75 feet. The relative positions of the various yachts were signaled while the races were in progress over a distance of 10 miles, and were published long before the yachts returned to the harbor. During the several days that the system was in use over 700 messages were sent and received, none requiring to be repeated. On trying longer distances it was found that with a height of 80 feet on the ship and the same height of 110 feet on shore it was possible to communicate up to a distance of 25 miles.

In December, 1898, the officials of Trinity House authorized the establishment of wireless communication between the South Foreland light-house at Dover and the East Goodwin light-ship, 12 miles distant. The installation started working without the slightest difficulty, and the system has continued to work admirably through all the storms, which, during this year, have been remarkable for their continuance and severity. On one occasion, during a strong gale in January, a heavy sea struck the ship, carrying part of her bulwarks away. This mishap was promptly telegraphed to Trinity House. On several occasions warnings of wrecks and vessels in distress have been signaled from the East Goodwin light-ship to the South Foreland light-house.

In March, 1899, this system of wireless telegraphy was put to its most severe test in experiments across the English Channel, between Dover and Boulogne, a distance of 32 miles. The tests were witnessed by a committee appointed by the French Government, and the messages transmitted were received and read with as much distinctness as though the termini had been connected by cable.

Various applications of this system have since occurred and have met with uniform success. It played an important part in the British naval manœuvres of this year, and proved so satisfactory to the British Admiralty that a complete outfit has been supplied to the *Defiance*, the torpedo school-ship at Devonport, for further experiments by naval officers.

More recent still is the part played by this system in reporting the international yacht race between the *Columbia* and *Shamrock*, and while the distances covered were much less than those already attained, it was the first practical demonstration of the possibilities and usefulness of wireless telegraphy in this country.

The speed of signaling by this system appears to be from 12 to 18 words a minute. It is stated, however, that a speed of 22 words has been attained, and this may doubtless be very materially increased.

Hitherto one of the chief objections to the use of wireless telegraphy has been the impossibility of concentrating the message, or in other words, to cut out a station and prevent a message from being received at other stations having installations within the radius of that for which the message was intended. Mr. Marconi claims to have an arrangement by which this can be overcome. In some experiments carried out on board the French dispatch boat *Ibis* last April, having on board a French commission, messages sent from the *Ibis* to the South Foreland were concentrated there, the East Goodwin light-ship being cut out. Similarly messages were sent to the light-ship, while the South Foreland was cut out. As a further test messages were sent simultaneously from Boulogne and the light-ship to the South Foreland, where the Boulogne message only was taken by the receiver, the other being cut out at will. This possibility is as yet, however, in its experimental stage, and at present it may be assumed that but one transmitter can be operated in the same neighborhood. The tests thus far made and the existing Marconi installations demonstrate the practicability of wireless telegraphy. It is stated that signals are now transmitted over 100 miles.

At the conclusion of the yacht races, Mr. Marconi conducted a series of experiments for the Navy Department under varying conditions with a view of testing its value for service use. For this purpose, sets of apparatus were installed on board the *Massachusetts* and *New York* and a third set on shore at the Highlands of Navesink. The first tests were at short distances while the two ships were at anchor in North River. These were followed by experiments over varying distances, the *Massachusetts* proceeding to sea, while the *New York* remained at her anchorage in North River. Messages were received by the former all the way to Sandy Hook light-ship, but those sent by the *Massachusetts* failed to be received on the *New York* through fault of a poor earth connection on the latter.

The *New York* then anchored 5 miles off Navesink, while the *Massachusetts* proceeded to sea for distance and interference tests. During the time the *Massachusetts* was under way messages were exchanged between her and the *New York* at intervals of ten minutes, interference messages being sent from Navesink at certain times with the result that when the New York and Navesink stations operated simultaneously, the *Massachusetts* received unintelligible signals. The *Massachusetts* and *New York* communicated up to 36 nautical miles.

Advantage was taken of a gale to test this system under what would seemingly be the most unfavorable conditions. The *Massachusetts* anchored inside Sandy Hook and the *New York* in Gravesend Bay. Both ships lowered the sprits to which the vertical wire was attached and hoisted the latter to their mastheads. In spite of wind, rain, and fog, communication was perfect.

The Naval Board appointed to conduct the above experiments reported as follows:

> We respectfully submit the following findings as the result of our investigation of the Marconi system of wireless telegraphy: It is well adapted for use in squadron signaling under conditions of rain, fog, darkness, and motion of speed. Wind, rain, fog, and other conditions of weather do not affect the transmission through space, but dampness may reduce the range, rapidity, and accuracy by impairing the insulation of the aerial wire and the instruments. Darkness has no effect. We have no data as to the effects of rolling and pitching, but excessive vibration at high speed apparently produced no bad effect on the instruments, and we believe the working of the system would be very little affected by the motion of the ship. The accuracy is good within the working ranges. Cipher and important signals may be repeated back to the sending station, if necessary, to insure absolute accuracy. When ships are close together (less than 400 yards), adjustments, easily made, of the instruments are necessary. The greatest distance that messages were exchanged with the station at Navesink was 16.5 miles. This distance was exceeded considerably during the yacht races, when a more efficient set of instruments was installed there. The best location of instruments would be below, well protected, in easy communication with the commanding officer. The spark of the sending coil or of a considerable leak, due to faulty insulation of the sending wire, would be sufficient to ignite an inflammable mixture of gas or other easily lighted matter, but with the direct lead (through air space, if possible) and the high insulation necessary for good work no danger of fire need be apprehended.
>
> When two transmitters are sending at the same time all the receiving wires within range receive the impulses from transmitters, and the tapes, although unreadable, show unmistakably that such double sending is taking place. In every case, under a great number of varied conditions, the attempted interference was complete. Mr.

Marconi, although he stated to the Board before these attempts were made that he could prevent interference, never explained how nor made any attempt to demonstrate that it could be done. Between large ships (heights of masts 130 and 140 feet) and a torpedo boat (height of mast 45 feet), across open water, signals can be read up to seven miles on the ship. Communication might be interrupted altogether when tall buildings of iron framing intervene. The rapidity is not greater than twelve words per minute for skilled operators. The shock from the sending coil of wire may be quite severe and even dangerous to a person with a weak heart. No fatal accidents have been recorded. The liability to accident from lightning has not been ascertained. The sending apparatus and wire would injuriously affect the compass if placed near it. The exact distance is not known and should be determined by experiment. The system is adapted for use on all vessels of the navy, including torpedo boats and small vessels, as patrols, scouts, and dispatch boats, but it is impracticable in a small boat. For landing parties the only feasible method of use would be to erect a pole on shore and then communicate with the ship. The system could be adapted to the telegraphic determination of differences of longitude in surveying. The Board respectfully recommends that the system be given a trial in the Navy.

In a letter to the Naval Board, Mr. Marconi stated that he was unable to give a demonstration of the devices used for preventing interference, and of the means used for tuning or syntonizing the instruments, the reason given being that they were not completely patented and protected. It should also be stated that Mr. Marconi, before conducting these experiments, stated that the distance of transmission would not be so great as that obtained during the British naval manœuvres, as the apparatus brought was for the purpose of telegraphing the result of the yacht races, where long-distance transmission was unnecessary.

The advantages claimed for this system are its cheapness, and the ease and rapidity with which it can be transported and installed. In the occupation of colonial territory, for communication between vessels and the shore or other vessels, the system is invaluable. As the system now stands, the lack of secrecy, its susceptibility to interference, the fact that at best there can be only a limited number of stations within a given radius, and the slowness of transmission, all tend to limit its use to some such purpose as indicated.[1]

WIRELESS TELEPHONY.

It has often been noticed that a bather immersed in water hears with great distinctness the sound of a steamer's engine in motion, because the water in which the latter is immersed is in a special state of vibration owing to the movement of the engine and the screw actuated thereby.

On this principle Dr. Mario Russo d'Assar, a Sicilian professor, concluded that if the ear could seize these vibrations of sound, an instrument of greater sensibility, functioning below water, could detect them at a greater distance and with greater distinctness. He accordingly devised a submarine sound indicator for determining the position of a ship relatively to the one upon which it is fitted. The invention depends for its action upon the vibrations caused by the propelling machinery of ships being collected and transmitted to telephonic apparatus placed in convenient position on the ship.

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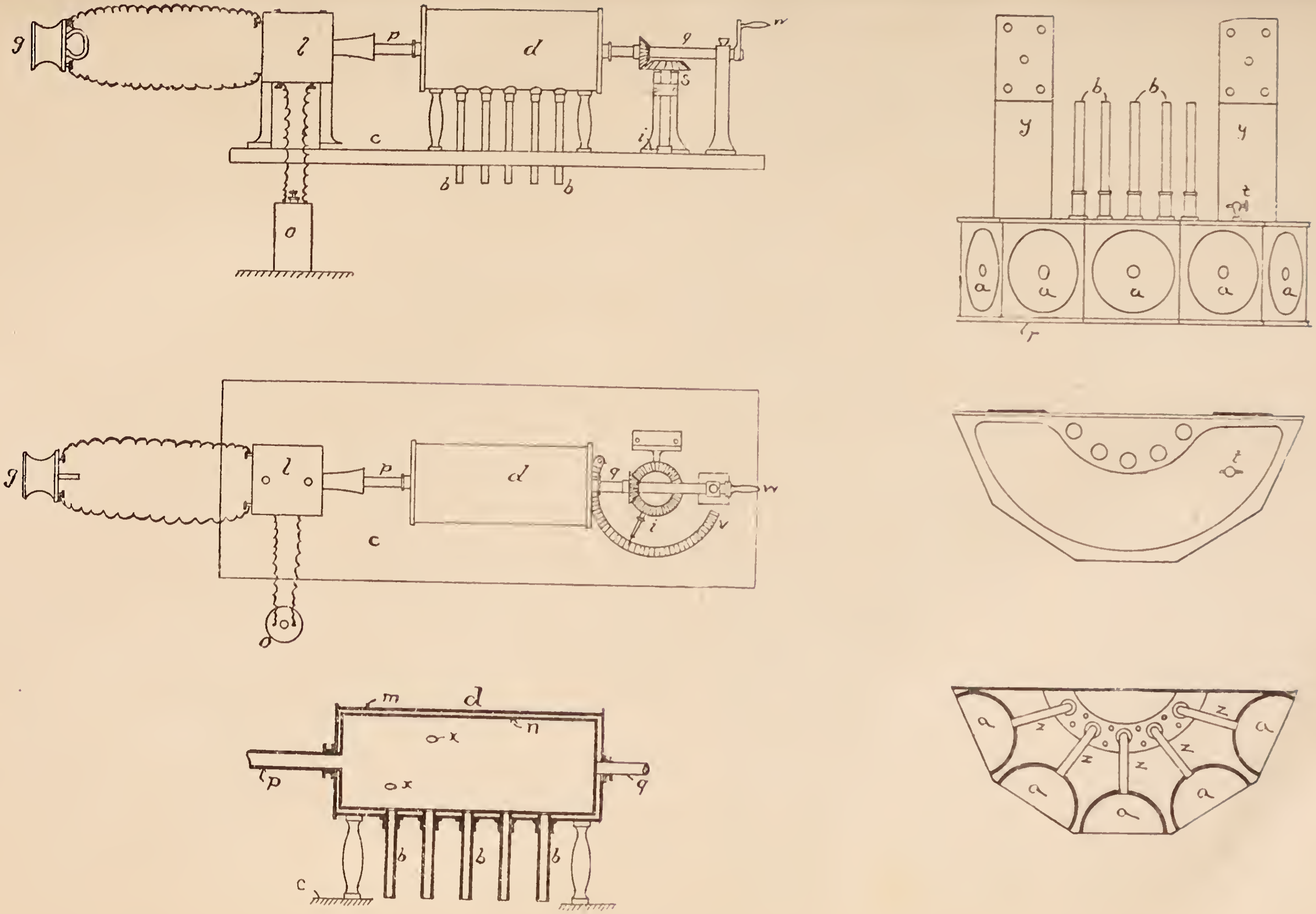
[1] The Daily Mail's Cape Town correspondent says that the experiments with the Marconi system of wireless telegraphy between DeAar and Modder River have met with small success, the iron in the hills beyond Enslin playing all sorts of pranks with the system. (Mr. Marconi thinks that if there is any difficulty, it is due to imperfect earth connection.)

The apparatus consists of a sound collector *r* (*see* plate), having faces at angles to each other, and an exhaust cock *t* through which the air is exhausted. Each face is provided with a mirror *a*, the arrangement being such that their axial lines converge toward the rear wall of the box. In the focus of each mirror a circular opening is provided, connected to a metal tube *z*. All these metal tubes are curved and terminate in the cover of the box, whence, by means of the flexible tubes *b*, they are connected to the indicator. The collector *r* is fixed by means of brackets *y* to a side of the ship, so that it remains permanently immersed in the water, while the tubes *b* are carried into the ship and connected to the direction indicator *d*. This direction indicator is formed of two concentric metal cylinders. The outer cylinder *m* is fixed and supported by two small columns on a base *c*. On the under side it is provided with as many openings having corresponding sockets as there are mirrors in the collector *r*. To these sockets are secured the tubes *b* coming from the collector. The second cylinder *n* is inside the first and is adapted to turn on bearings in the ends of cylinder *m*. This second cylinder *n* terminates at one side in a tube *p* and at the other side in a small shaft *q*. It is also provided with five openings in line with each other in the direction of its length, which correspond with the five openings of cylinder *m* so that they may coincide. In addition to these openings the cylinder *n* is furnished with five other openings *x*, arranged so that at each sixth of a turn one of these openings will correspond with one of the five openings of cylinder *m*.

The small shaft *q* which terminates in a crank *w* is connected by bevel gear to a spindle *s*. On this spindle a handle *i* is fixed, which indicates upon the graduated dial *v* which one of the openings of cylinders *m* and *n* coincide. The tube *p* extends to a microphone *l*, which communicates with a battery *o* and telephone *g*.

The operation is as follows: When the five openings of cylinder *n* correspond with the five openings of cylinder *m*, the interior of cylinder *n* receives the sounds collected by all the five mirrors. On giving cylinder *n* a sixth of a turn the first hole *x* coincides with the first hole of *m* and there will only pass the vibrations collected by the first mirror. On revolving *n* another sixth of its circumference the second hole of each cylinder will coincide and the vibrations collected by the second mirror only can pass into *n*, and so on. There can thus be transmitted to the microphone and telephone either the vibrations



D'ASSAR APPARATUS.

collected by all the mirrors or only those collected by a single mirror, according as is indicated by the index upon the dial.

The normal position of the apparatus is, of course, with all of the openings of the two cylinders, coincident. Upon a ship arriving within the radius of sensibility (4½ miles), the vibrations will cause a bell to ring. By rotating the cylinder and thus eliminating successive reflectors her approximate bearing will be indicated; and as this passes from one collector to another, or, in the case of a vessel approaching direct, by the intensity of sound, her approximate course may be determined.

Having ascertained and confirmed by experiments the practicability of the above system, Professor d'Assar next connected with the indicator a graphic apparatus, which registers rapid and slow strokes, systematized so as to form a conventional alphabet, by means of which two ships can correspond with each other. These strokes are printed in the shape of dots on a strip of paper which unwinds from the graphic apparatus. Thorough trials of the Russo d'Assar telephone have demonstrated its usefulness, which is confirmed by the scientists and naval experts who witnessed the experiments made in the Gulf of Genoa on board the Italian gunboat *Scilla.*

XI.

THE PRINCIPAL NAVIES OF THE WORLD IN 1898.*

By Naval Constructor SÜSSENGUTH, *Imperial German Navy.*

[Translated from the Marine Rundschau, March, 1899.]

The unusual development of traffic and navigation during the last ten years, the tendency toward expansion of colonial possessions, and other reasons have caused in almost all countries a greater expenditure for the increase and maintenance of navies.

The following table will give an idea of the naval budgets of the different powers:

Expenses in million marks.

	1897.		1898.		1899.		Estimates proposed or granted for new constructions and armaments.	
	Total budget.	For new constructions and armaments.	Total budget.	For new constructions and armaments.	Total budget.	For new constructions and armaments.	Total.	For one year.
England..........	450	250	[1] 580	[1] 370	....	[1] 370	....	[1] 370
France..........	202	94	230	121	250	....	....	....
Russia..........	223	74	260	121	....	....	300	[1] 180
Germany..........	118	49	122	51.4	....	55	482	[1] 60
United States......	138	55	338	219	224	105	....	[1] 200
Japan..........	147	128	180	150	200	160	[1] 400	[1] 70
Italy..........	82	37	82	44	....	[1] 80	240	[1] 80
Austria..........	23	6	25	6	28	15	90	[1] 27

[1] Approximately.

It will be seen from the last column that, although there is a general idea prevailing that particularly high demands have been made in Germany on the taxing capacity of the country, this is not the case, and that the annual amount of our budget for new constructions does not even reach the amount required for the same purpose in Italy during the next few years, although our merchant marine is three times as large as that of the latter country.

Relative to the cost of modern battleships in different countries, the chief constructor of the English navy publishes some figures according to which the English battleships *Nile* and *Trafalgar*, 1885, cost 17,000,000 marks each, while those of the *Royal Sovereign* class cost something less, and those of the *Majestic* type something more. The cost of the *Powerful* was 13,600,000 marks. These figures indicate the cost of construction exclusive of armament and ammunition. The new French battleships cost 20,000,000 marks each, the United States *Indiana* 18,800,000, and the latest German battleships 14,000,000 marks. By figuring the price per ton for the purpose of comparison, using that of the *Majestic* as a base, and calling it 1, the *Nile* costs 1.28 per ton, the French battleships 1.39, the *Indiana* 1.42, and the *Kaiser Friedrich Wilhelm* only 1.06 per ton. If we take into consideration that the last-named ship has been equipped with the new Krupp armor, which costs about one-fifth more than the armor employed on the *Majestic*, it will be seen that Germany is able to build her warships as cheaply or even more cheaply than England, which, in view of the very recent beginnings of German naval construction, must be considered an excellent result. In France the high cost of ships for war and commercial purposes appears to be due to the sluggish working of the administration. As to Russia, Sir William White was unable to give figures, but it is his opinion that they will be very high as regards the new Russian cruisers.

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*NOTE.—This translation originally appeared in April, 1899, as General Information Series No. XVIII, Part I, and its incorporation herein cancels Part I as a separate issue.—O. N. I.

The number of new ships to be constructed is in harmony with the increased budgets of the different powers. The following table will show the status of the different navies according to a report issued by the British Parliament in July, 1898:

	Completed.							Under construction.						
	England.	France.	Russia.	Germany.	Italy.	United States.	Japan.	England.	France.	Russia.	Germany.	Italy.	United States.	Japan.
Battleships	52	27	12	9	15	5	3	12	8	6	5	2	8	3
Armored cruisers	18	9	10	3	3	2	1	8	10	1	2	2	....	6
Protected cruisers	95	30	3	7	15	14	10	24	10	3	8	3	1	6
Unprotected cruisers	16	16	3	21	1	10	8	....	....	....	....	....	....	1
Coast-defense ships	15	14	15	19	.....	[1]20	3	....	....	1	....	....	....	....
Torpedo vessels	35	13	17	2	15	....	1	....	2	....	....	....	....	....
Ships for special purposes	3	1	5	1	2	1	....	....	....	....	....	....	....	....
Torpedo-boat destroyers	50	.....	1	.....	.....	.....	....	46	8	28	1	1	20	8
Torpedo boats	98	211	114	113	142	[2]8	44	....	38	....	9	2	22	12

[1] Including 6 double-turret monitors, 13 old single-turret monitors, and the ram Katahdin. The 13 old monitors would hardly be included in computing the strength of the Navy on the usual basis of age, speed, etc.—(O. N. I.)

[2] Torpedo boats completed, 13; under construction, 13.—(O. N. I.)

The above table shows that Japan is the only country building unprotected cruisers at the present time. Hence, it appears to be the intention of all the other nations to be represented abroad only by protected and efficient cruisers, especially since the battles of the Yalu and of Cavite and Santiago have removed the last doubt as to the worthlessness of unprotected ships in battle. The reason why coast-defense vessels are no longer being built except in Russia may be sought in the tendency of the powers to construct in their place only such ships as are adapted for battle on the open sea, viz, battleships. As a general thing, the question as to whether two small vessels would not be preferable in a battle to one ship twice as large has everywhere been decided in favor of the one large ship. All countries are at present building battleships of about 12,000 tons, England and Japan even of 15,000 tons, which latter displacement, as far as now known, is also contemplated for the new battleships to be commenced in France during the present year. The results of the battles of the Yalu and Santiago have shown the wisdom of such action. At the Yalu, the two Chinese battleships, which in offensive and defensive power were superior to the Japanese armored cruisers, were not put out of action, although the Japanese were at a great advantage by reason of the large number of their ships that were still in fighting condition at the end of the battle. At Santiago, the large American battleships soon brought about the destruction of the Spanish ships. Another circumstance in favor of the employment of large ships is the difficulty of providing the requisite trained complements for all the ships. A large ship does not require as large a crew as two vessels half the size. If, nevertheless, some of the powers are building smaller battleships, it may be safely assumed that the reason is lack of funds or that the ships in question are intended for limited modes of warfare.

ENGLAND.

The value of the English navy, which in 1887 amounted to 740,000,000 marks, has now risen to 1,944,000,000 marks, exclusive of torpedo boats. The total displacement is 955,000 tons, and will reach 1,000,000 tons in the course of the next year. The total horsepower of all the ships' engines, again exclusive of torpedo boats, amounts to 1,575,000 tons.

The budget allowed for 1898–99 amounts to about 480,000,000 marks. Hence it exceeds that of the previous year by only about 30,000,000. The small increase is due, first of all, to the fact that, by reason of the great strikes among metal workers in England, the credits of the preceding year were not exhausted. The construction of the first-class battleships *Cæsar*, *Illustrious*, and *Hannibal*, for instance, has been so retarded that they could not begin their trial trips until the present year. The construction of the *Diadem* also has been delayed. As a further reason, it is stated that the 30.5-centimeter and 15-centimeter guns for the new ships had to be tested and remodeled to suit modern requirements; moreover, that the armor-plate factories were behind with their orders, owing to experiments with the new hardening process (Krupp process). It is also stated in the budget report that the plans of the four new battleships heretofore granted—the *Vengeance* (*Canopus* type), *Implacable*, *Irresistible*, and *Formidable*—had been completed and the ships given out for construction. Three new battleships are asked for (now named the *London*, *Venerable*, and *Bulwark*), which, with slight deviations, are to follow the *Formidable* type—length, 121.9 meters; beam, 22.8 meters; mean draft, 8.15 meters; displacement, 14,900 tons; I. H. P., 15,000; the armament consists of four 30.5-centimeter, twelve 15-centimeter, and thirty small R. F. guns; also four armored cruisers—the *Cressy*, *Aboukir*, *Hogue*, and *Sutley*—and four sloops. The intention was to have under construction or engaged in trial trips during the past year 12 battleships, 16 first-class cruisers, 6 second-class cruisers, 16 third-class cruisers, 6 sloops, 4 twin-screw gunboats, 41 torpedo-boat destroyers, and 1 royal yacht.

Of other items of the budget we will mention the appropriation of the necessary funds for the acquisition of 200 new Whitehead torpedoes to take the place of 300 antiquated torpedoes that have been condemned; also the introduction of the Lee-Metford rifle.

Now that the program of naval constructions submitted by the Government has been allowed, the English navy should feel strong enough to be able to meet with decided superiority the combined fleets of any two adversaries. Shortly after the approval of the program it became known that the Czar had allowed the sum of 300,000,000 marks, to be distributed over three or four years, for the increase of the Russian fleet, in addition to the regular budget for new constructions. This report produced considerable excitement in England and caused the British Admiralty to submit to Parliament in July last a supplement to the naval estimates. The result was that in England also 300,000,000 marks, to be distributed over three years, were voted by a large majority, which shows how easily the English are aroused at the slightest menace to their naval supremacy and how well the nation has been trained to understand the importance of protecting its commerce and colonies.

The following table gives an idea of the floating material now under construction and to be completed within three years at the latest, which alone is superior in power to the total German navy as it will be constituted at the completion of the naval programme in 1903:[1]

	Already launched.	Under construction.	Not yet begun.
Battleships	4	5	7
Armored cruisers and first-class cruisers	4	7	6
Second-class cruisers	5	1	....
Third-class cruisers	7	....	....
Gunboats	....	4	4

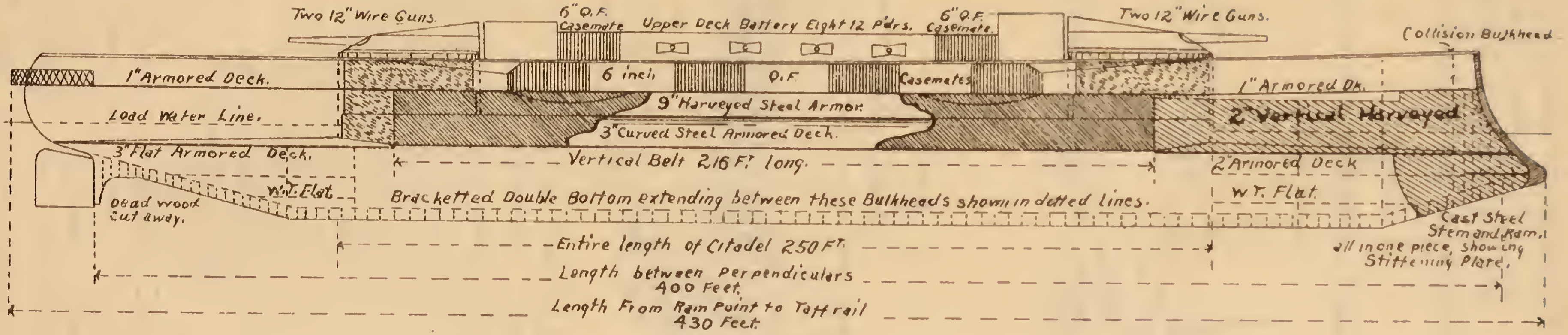
Exclusive of all ships and torpedo-boat destroyers already turned over for the purpose of trial trips.

In connection with the battleships, it should be noted that the four already launched and two of the ships under construction belong to

---

[1] This comparison is true of the United States Navy, as well as of the German. The increase in tonnage to be added to the British Navy within the next three years exceeds the total tonnage of the war vessels of the United States Navy, built and building, by more than 100,000 tons displacement.—(O. N. I.)

FIG. I.


Two 12" Wire Guns.
6" Q.F. Casemate
Upper Deck Battery Eight 12 Pdrs.
6" Q.F. Casemate.
Two 12" Wire Guns.
Collision Bulkhead
1" Armored Deck.
6 inch
Q.F.
Casemates
1" Armored Dk.
Load Water Line.
9" Harveyed Steel Armor.
3" Curved Steel Armored Deck.
2" Vertical Harveyed
3" Flat Armored Deck.
Vertical Belt 216 Ft. long.
2" Armored Deck
W.T. Flat
Bracketted Double Bottom extending between these Bulkheads shown in dotted lines.
W.T. Flat.
Dead wood cut away.
Cast Steel Stem and Ram, all in one piece, showing Stiffening Plate.
Entire length of Citadel 250 Ft.
Length between perpendiculars 400 Feet.
Length From Ram Point to Taffrail 430 Feet.

"FORMIDABLE."

SKETCH OF ARMOR.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

the *Canopus* class, of 12,950 tons displacement and 18.25 knots speed. These ships are sufficiently well known, and we will only show in a sketch how the forward part of the ship is to be armored, this being the first instance where England has extended the armor to the stem.

FIG. 2.
FORW'D PART OF "RESOLUTION".

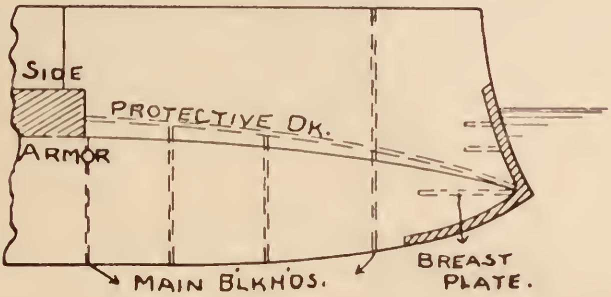
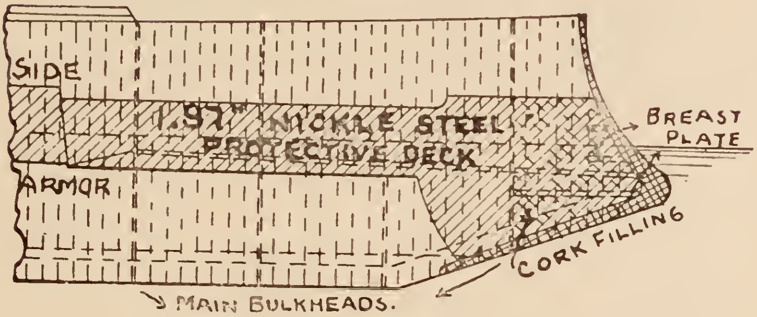


FIG. 3.
FOR'D PART OF "CANOPUS".



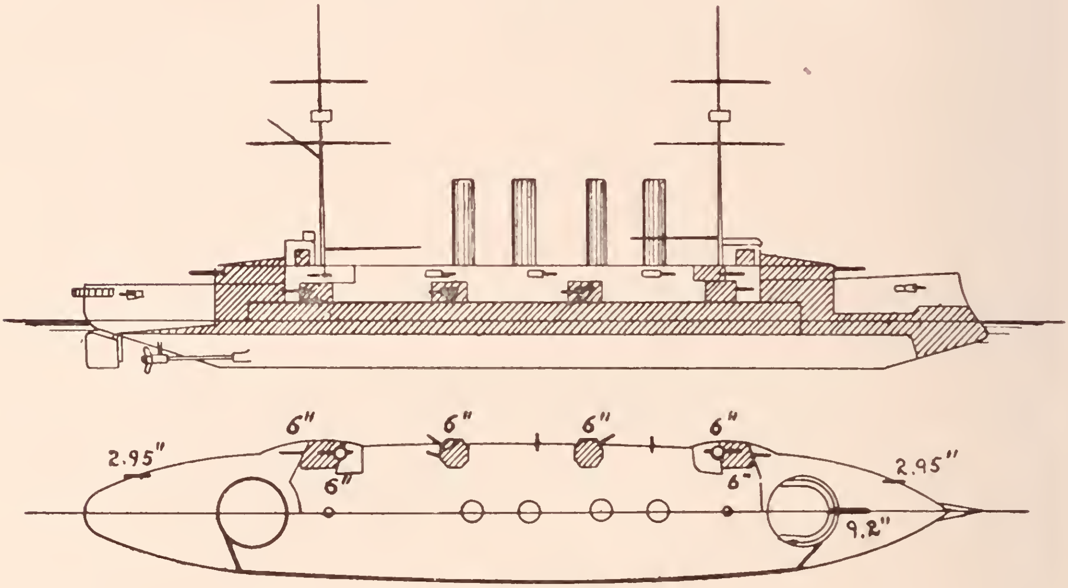
From the above sketch it will appear that the armor of these battleships is similar to that in use in Germany, Austria, and the United States, except that the thickness of the armor belt is only 50 millimeters, so that even small-caliber R. F. guns could pierce it. The unprotectedness of the extremities of English battleships is the subject of animated discussion in France, the opinion being that by the use of French melinite shells the outer skin forward and aft of the citadel could be completely destroyed, and this would permit the water to enter the protective deck and materially impair the manœuvering efficiency of the ship. On the other hand, the English think that a hit under the French barbette turret would cause its collapse.

The other three battleships under construction, and three of those not yet commenced, are to belong to one and the same type. They are the *Formidable*, *Implacable*, *Irresistible*, *London*, *Venerable*, and *Bulwark*, of 15,000 tons displacement and 18 knots speed. They are to receive even more extensive armor protection than the *Canopus* class, but in the installation of guns and other respects they are to be similar. The battleships not yet given out for construction are to receive less armor protection than the *Formidable* class, but greater speed and less draught, so as to enable them to pass through the Suez Canal.

From the above it is evident that all of the thirty-three first-class English battleships built during the last few years, or about to be built, belong to one and the same type, differing only in minor details, so that they can all be used for the same purpose and combined into squadrons in any manner desired.

The four cruisers already launched, and one of those under construction, belong to the *Diadem* class. The other four under construction, and two of those not yet begun, are the armored cruisers *Cressy*, *Aboukir*, *Hogue*, *Sutley*, *Bacchante*, and *Mutine*.

FIG. 4



"CRESSY."

As England has built no armored cruisers since 1886, when the rather unsatisfactory *Aurora* class was completed, it is somewhat startling that six armored cruisers should be included in this year's program; but when it is remembered that all of the large cruisers built by France during the last few years have been armored cruisers, and that six of these, with a displacement of 9,515 tons each, were laid down during the past year, this significant step on the part of the English Admiralty will be readily understood.

Moreover, it is the endeavor in England to build a type having all the characteristics of armored cruisers—speed, radius of action, etc., and being at the same time adapted to fight in squadron formation by the side of the new English battleships. The new *Cressy* class might be designated as a modification of the *Canopus* type. The weight gained by the decrease of the armament has been utilized for increassing the engine power and radius of action. The distribution of the medium artillery, the protection of the ship's hull and of the guns is the same. The dimensions are: length, 134 meters; beam, 21 meters; draught, 7.9 meters; displacement, 12,000 tons. With this displacement, the coal supply is only 800 tons; but the total capacity of the coal bunkers is 2,000 tons, in which case the displacement would be increased to 13,200 tons. In order to attain a speed of 21 knots, which is 3 knots in excess of that of the English battleships, the length had to be increased by about 14 meters, requiring 21,000 I. H. P. For other particulars as to armor and armament see figs. 3 and 4.

Two others of the cruisers not yet commenced are also to be armored cruisers, but of dimensions differing from those of the *Cressy* class. They are to be giants, like the *Powerful* and *Terrible*, of 151 meters length, 21.5 meters beam, 7.9 meters draught, 14,100 tons displacement, 1,250 tons coal supply, and 30,000 I. H. P. With all bunkers filled, the ships will be able to carry 2,500 tons of coal, raising the displacement to 15,350 tons. From Lord Goschen's speech on the budget it would appear that these two ships are to be built in order that the English navy may be able to oppose to the six new French armored cruisers, *Montcalm*, etc., and to the *Jeanne d'Arc*, an adversary superior in every respect. This is the same policy that England adopted when she constructed the *Powerful* and *Terrible*, the largest protected cruisers hitherto built. as an offset for the new American commerce-destroyers *Columbia* and *Minneapolis* and the Russian *Rurik*. These two cruisers were to prove last year whether they answered the purpose for which they were built; but so far they have not come up to expectations.

The total tonnage of all English cruisers under construction is greater than that of the cruisers contemplated or under construction of all other European powers together.

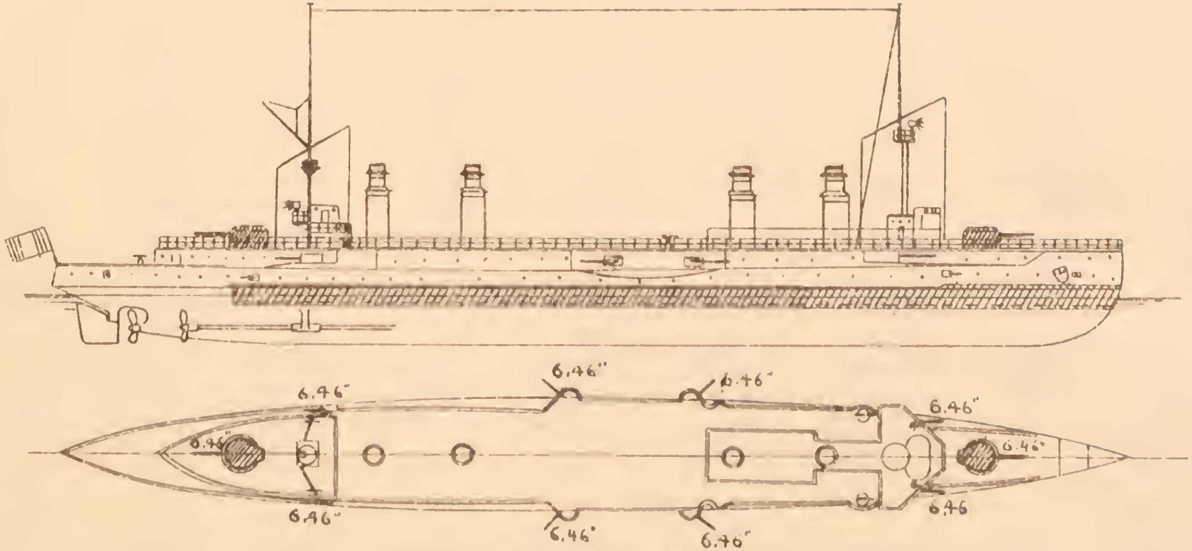
The river gunboats built for service on the Nile are quite remarkable. They are being transported by rail in eleven separate parts, each capable of floating by itself to above the cataracts of the Nile, where they will again be put together.

The following table gives the principal dimensions of all English ships under construction or completed during the past year:

[NOTE.—Sub. l. t. = submerged launching-tubes; a. w. l. t. = above-water launching-tubes; R. F. = rapid-fire guns.]

Name of type-ship	Pelorus.	Arrogant.	Hermes.	Diadem.	Cressy.	Powerful.	New large cruisers.	Majestic.	Canopus.	Formidable.
Number ships of type	11	4	3	8	6	2	2	9	6	6
Length ....meters	91.4	97.5	106.7	132.6	134.1	152.4	151	119	118.8	121.9
Beam ....do	11.12	17.48	16.5	21.0	21.2	21.6	21.5	23	22.5	22.8
Draught ....do	4.11	7.16	6.4	7.7	7.9	8.2	7.9	8.6	7.9	8.15
Displacement ....tons	2,135	5,810	5,600	11,000	12,000	14,200	14,100	14,900	12,950	14,900
Speed ....knots	20.7	19.6	19.5	20.75	21	22	23	17.5	18.25	18.5
Horsepower	7,028	10,290	10,000	18,000	21,000	25,000	30,000	11,000	13,500	15,000
Armor belt ....millimeters	....	....	....	....	152.4	....	152.4	228	152	228
Casemate ....do	....	....	....	152.4	152.4	152.4	152.4	150	152	(?)
Deck armor ....do	51	51	75-34	102-64	76-51	152-76	(?)	100-63	63	101-63
Armament	8 10-cm. 8 4.7-cm. 2 l. t.	4 15-cm. 6 12 cm. 8 7.5-cm. 2 sub. l. t.	11 12-cm. 8 R. F. 2 sub. l. t.	16 15-cm. 17 R. F. 2 sub. l. t.	2 23.3-cm. 12 15-cm. 17 R. F. 2 sub. l. t.	2 23.3-cm. 12 15-cm. 30 R. F. 2 sub. l. t.	2 23-cm. 16 R. F. (?)	4 30.5-cm. 12 15-cm. 16 7.5-cm. 12 4.7-cm. 1 a. w. l. t. 4 sub. l. t.	4 30.5-cm. 12 15-cm. 12 7.5-cm. 6 4.7-cm. 4 sub. l. t.	4 30.5-cm. 12 15-cm. 16 7.5-cm. 12 4.7-cm. 1 a. w. l. t. 4 sub. l. t.
Coal supply ....tons	250	1,175	550-1,050	1,000-2,000	800-2,000	1,500-2,500	1,250-2,500	900-2,250	1,900	(?)
Complement	224	419	450	(?)	(?)	900	(?)	(?)	750	(?)

FIG. 5.



"DESAIX."

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

FRANCE.

For the year 1897 the ministry submitted to the Chamber a demand for 210,000,000 marks for new constructions, to be completed within eight years. Recognizing the necessity of a strong navy, the people's delegates shortened the period to three years, with the only limitation that the principal sum should be used for the construction of new armored cruisers and about 50,000,000 marks for the remodeling of older ships. For the year 1898 the construction of one battleship (instead of two asked for by the administration), three armored cruisers (instead of one), and eleven torpedo boats was voted, also the necessary funds for completing the ships then under construction. The installment of the heavy guns of the *Suffren* is to be the same as that of the *Jauréguiberry* (four single turrets); but the secondary battery is to be installed in casemates, the same as in the *Brennus*. By the end of the year the following ships will still be in process of construction: Three battleships—*Jéna*, *Suffren*, and *Henry IV;* six armored cruisers of 9,515 tons displacement—*Gueydon*, *Dupetit Thouars*, *Montcalm*, *Le Condé*, *Sully*, and *Gloire;* three armored cruisers of 7,700 tons—*Desaix*, *Kléber*, and *Dupleix;* also the *Jeanne d'Arc*, and finally the station cruisers *Guichen*, *Châteaurenault*, and *Jurien de la Gravière.*

In the discussion of the budget it was particularly pointed out that France had recently built too many different types, as will also appear from the table of French warships given below. The constant changes of dimensions, armor, and distribution of armament prove either that France has hitherto had no definite aim in view, or that former constructions have not proved satisfactory. This may be one of the reasons why the building of warships is so expensive in France. The new minister recognizes these drawbacks. Six armored cruisers, of 9,500 tons displacement, have therefore been ordered, and three of 7,700 tons.

At a first glance it may seem strange that France has asked for only one new battleship, the *Suffren*, but this will be more easily understood if it is remembered that the *Montcalm* class possess all the requirements of battleships, with the exception of the heavy armament. Perhaps, too, France has recognized that her navy, even with the Russian for an ally, is no match for the English navy, and intends in the future, in case of war, to use her battle fleet only for the protection of the coast, but her armored cruisers for the destruction of English commerce, in the face of historical facts and competent opinion.

This intention is given expression in the three protected cruisers. As far as possible these ships are to have the aspect of merchant vessels—straight or overhanging bow and stern, pole masts with gaffs, without fighting tops, etc. The *Guichen* and *Châteaurenault* are to be of the same dimensions as the United States commerce destroyers *Columbia* and *Minneapolis*, but the new French ships are better suited for their purpose. For instance, the coal supply of the *Columbia* is

1,500 tons, while that of the *Guichen* is 2,100 tons. We have already stated that the empire of the sea can be achieved only with battleships in actual battle, and not with cruisers intended to destroy the enemy's commerce.

The following ships made their trial trips last year: Battleships *Masséna*, *Charlemagne*, *Gaulois*, *St. Louis*, and *Bouvet;* armored cruiser *D'Entrecasteaux*, and cruisers *Cassard*, *Catinat*, *D'Assas*, *Lavoisier*, *Galilée*, *D'Estrées*, *Infernet*, *Protet*, *La Hire*, and *Dunois*. The *Guichen* commenced her trial trips this year, as provided for in the program. As a general thing all the trial trips have been satisfactory, the *Masséna* being the only ship requiring extensive repairs to the hull. After she had been entirely equipped, it appeared that she was top-heavy, so that at the trial trips the bow buried into the sea considerably; consequently the contract speed was not attained and the steering efficiency was inadequate. The latter defect has since been remedied by enlarging the rudder, and the former by shifting weights and taking on ballast. A few years ago the *Magenta* class and the *Hoche* had also to undergo modifications which cost several million marks, as the stability of the ships proved to be insufficient.

In the following table only the ships under construction have been included:

Name of ship or class	Henry IV.	Jéna.	Suffren.	Jeanne d'Arc.	Châteaurenault.	Jurien de la Gravière.	Guichen.	Montcalm.	Dupleix.
Number of ships	1	1	1	1	1	1	1	6	3
Length	108	122.15	125.5	145.4	135	137	133	138	130
Beam	22	20.8	21.36	19.4	17	15	16.77	19.4	17.8
Draught (mean) ... meters	7.0	8.4	7.95	8.12	6.85	6.05	7.5	7 5	7.5
Displacement ... tons	8,948	12,052	12,728	11,270	8,018	5,686	8 277	9,517	7.709
Speed ... knots	17	18	18	23	23	23	23	21	21
Horsepower	11,500	15,500	16,200	28.500	23,000	17.400	23,670	19 600	17.000
Belt armor ... millimeters	(?)	350	(?)	150–50	....	....	....	150	102–84
Armor of superstructures ... do	(?)	120–80	(?)	80–40	....	....	....	115	....
Deck armor ... do	(?)	65	(?)	55	35	45	35	50	50–22
Armament	2 27 cm	2 30.5-cm	4 30.5-cm	2 19.4-cm	2 16.4-cm. in 54-mm. shield.	8 16-cm	2 16.4-cm. in 54 mm. shield	2 19 cm. in turret, 8 16-cm. in casem.	10 16-cm. (2 in turret, 8 in 100 mm. casemate).
	7 14-cm	8 16-cm. in casem.	10 16-cm. (4 in casem., 6 in turrets).	8 14-cm. in casem.	6 13.8-cm. in 54-mm. shield.	10 4.7-cm	6 13.8-cm. in 54-mm. shield.	4 10-cm	10 4.7.cm.
	12 4.7 cm	8 10-cm. in 54-mm. shields.	8 10-cm	10 10-cm	10 4.7 cm	6 3.7-cm	10 4.7-cm	16 4.7-cm	....
	2 sub. l. t	16 4.7-cm	20 4.7-cm	16 4.7 cm	....	2 sub. l. t	....	2 sub. l. t	....
				2 sub. l. t	....	....	....	....	....
Coal supply ... tons	1,100	800–1,100	820–1,150	1,400	1,400–2,100	1,400–1,860	1.400–2,100	1,020–1,600	880–1,200

For 1899, two battleships of 14,500 tons with complete armor belt and two dispatch cruisers of 4,000 tons have been granted. In addition to these, the supplementary budget asked for one armored battleship, A 8 (Brest), one armored cruiser of the *Montcalm* type (C 9), two protected cruisers (H 4 and H 5), and six submarine boats (*Narval* type).

Six torpedo-boat destroyers have been given out for construction, namely, *Fouconneau*, *Espignole*, *Pique*, *Epée*, *Framée*, and *Yatagan*, of 50.6 meters length, 5.25 meters beam, 3.02 meters draught, 311 tons displacement, 5,700 horsepower, two deck launching tubes, and a probable speed of 26 knots. There are also under construction or undergoing trials the submarine boats *Gymnote*, *Morse*, and *Gustave Zédé*. These will again be referred to.

The *Amiral Baudin* is being reconstructed, the most important change being the substitution of four 16-centimeter R. F. guns in modern casemates for the central 37-centimeter gun in barbette. The former installation of the heavy guns was similar to that of the German *Brandenburg* class, namely, in three turrets amidships.

The same changes were made in 1897 in the *Formidable*, a sister ship of the *Amiral Baudin*. The boilers have also been changed in these ships. Both have already been placed in commission, but they do not yet have the new casemate armor on board. The reason is said to be that the armor is not yet ready.

The three armored coast-defense vessels, *Indomptable*, *Caïman*, and *Terrible*, are to receive less heavy armament, which will lighten the weight of these ships, for when completely equipped the upper edge of the armor now dips below the surface of the water.

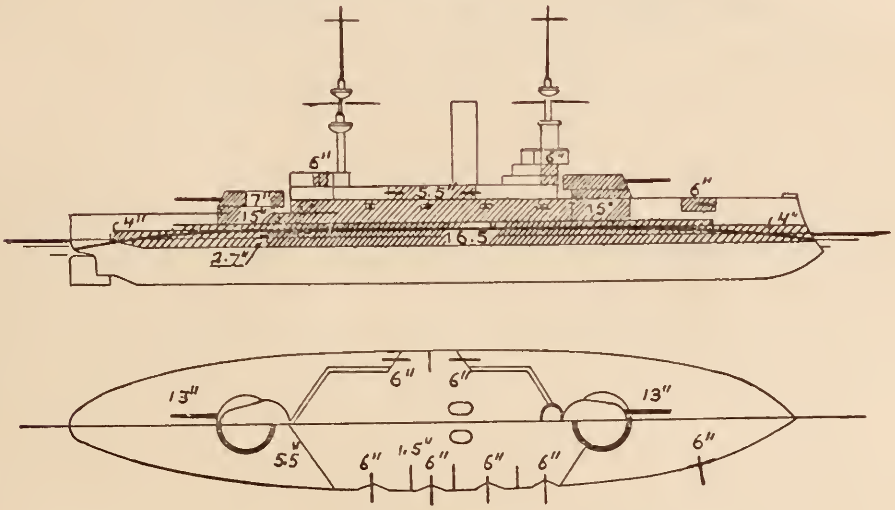
The dispatch boat *Fleurus* is again ready for trial trips. She was launched as early as 1893. The first trial trips were not satisfactory, and the vessel has since been equipped with Niclausse boilers, so that it will be six years from the time of launching before she will be ready for service. Her speed is said to be only 17 knots.

UNITED STATES.

At the beginning of the year 1898 the following vessels were under construction: Battleships *Kearsarge*, *Kentucky*, *Illinois*, *Alabama*, and *Wisconsin;* gunboat *Princeton*, and sixteen torpedo boats.

None of the larger ships were completed for trial trips in the course of the year. The original naval estimates for 1898 were 128,000,000 marks (35,000,000 marks alone for new constructions), being 10,000,000 marks less than for the preceding year, as it was not the intention to lay down any new large ships. The reason for this was that great difficulties had been encountered in procuring the armor plate for the ships under construction, or that the prices asked for such armor by the manufacturers were too high. But in the discussion of the appropriation bill the laying down of one large battleship was asked for without at first increasing the amount of the estimates. Shortly before the beginning of the Spanish-American war, however, the above figures were increased for the purpose of purchasing additional ships, and at the same time it was recognized that a larger fleet was absolutely necessary, and as a result a bill was passed to lay down during the year three battleships and four armored coast-defense vessels. The battleships were to be of 11,000 tons displacement and of only 16 knots speed. In explanation of the slow speed the Secretary of the Navy made a statement to the effect that a speed of 16 knots is sufficient for United States battleships as long as the ships of other nations do not exceed the rate of 18 knots, and that by making the speed and coal capacity less than for foreign battleships, the United States ships, with the same offensive and defensive qualities, can be built smaller and at less expense.

FIG. 6.



"ALABAMA"

But after the termination of the war, the issue of which was so extremely favorable for the United States, the fleet gained quite a different significance, because the United States, as a result of the war, has entered the ranks of colonial powers and will now require ships of large coal capacity and great speed. The program for the increase of the Navy, for which 220,000,000 marks were voted for new constructions and armament alone, was therefore changed, and now includes three battleships of 13,500 tons, three large armored cruisers of 12,000 tons, three protected cruisers of 6,000 tons,[1] and six unprotected cruisers of 2,500 tons, all of which are to be commenced, if possible, during the present fiscal year, as the funds become available for the Secretary of the Navy on January 1, 1899. Hence there will be under construction in the United States in the course of 1899 eleven battleships, four armored coast defense vessels, three first class armored cruisers, six protected and six unprotected cruisers. The three battleships already given out for construction are the *Maine*, *Missouri*, and *Ohio*.[1] The following sketch shows the distribution of armor and armament.[2]

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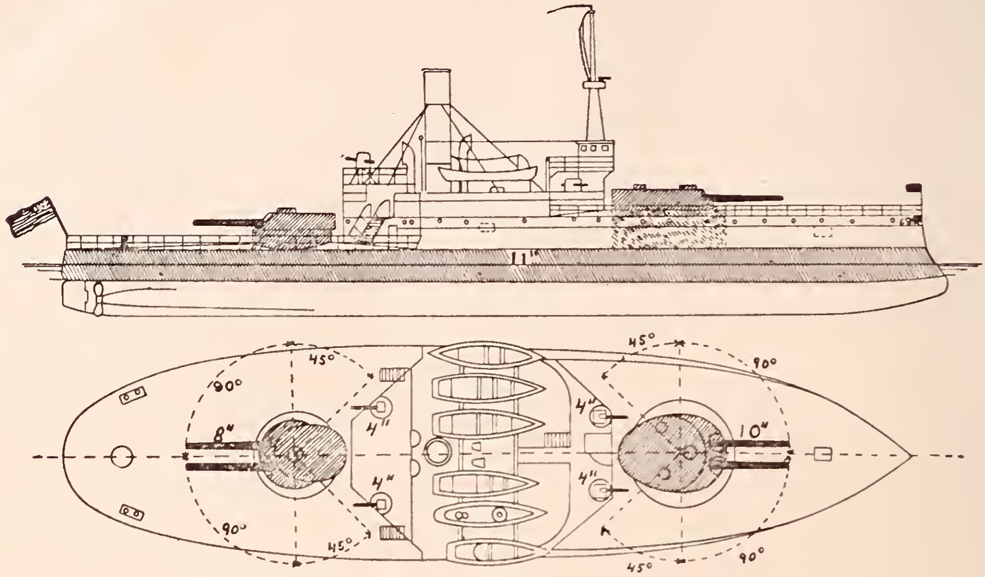
[1] The three protected cruisers of 6,000 tons were not appropriated for.—(O. N. I.)

Fig. 7.



The draught is to be 7.75 meters. It is stated that all United States ships are in future to have a wooden skin sheathed with copper.[3]

The four new armored coast-defense vessels, the *Arkansas*, *Connecticut*, *Florida*, and *Wyoming*, as shown by the sketch, are built after the pattern of the monitors—peculiar to the United States Navy—except that they have received an additional deck forward, probably for the purpose of making the ships more habitable for the crews rather than of improving their seaworthiness. Building the fore part of the ships 3 meters higher will hardly increase their seaworthiness, and will, moreover, make it impossible to use the bow gun when steaming against an even moderate head sea. The assumption is probably correct that a change in the type of these ships is desirable, if it can still be done, and according to the latest information this appears to be the intention.[4]

It is not easy to understand why the American ships have hitherto been given so little free board, and, independent of this, such narrow quarters for the crews; but the complements of American ships are comparatively small. The crew of the *Alabama*, for instance, consists of only 490 men, while the ships of our *Brandenburg* class, of 1000

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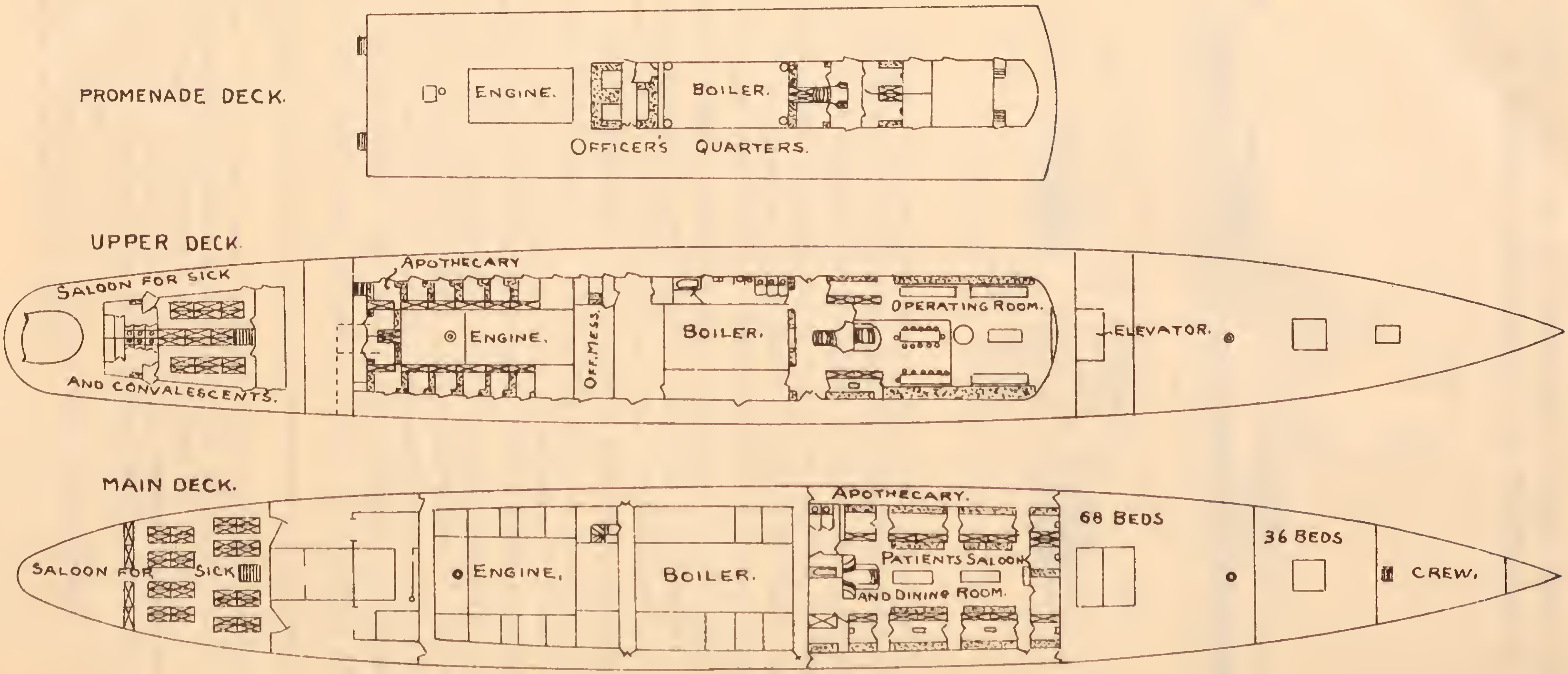
[1] These ships will be of 12,500 tons displacement and have a speed of 18 knots.—(O. N. I.)

[2] Figure 7 is the plan of a double-turret monitor prepared unofficially for parties who were seeking to procure appropriations for new vessels for the naval militia. It was illustrated in Yachting in the fall of 1897.—(O. N. I.)

[3] The statement that the new ships will have a wooden skin, sheathed with copper, is misleading. The ships will be built of steel, the underwater body sheathed with wood and coppered.—(O. N. I.)

[4] This is an error, as the new monitors will have no additional forward deck, but will be like the original type.—(O. N. I.)

FIG. 8.



U. S. HOSPITAL SHIP "SOLACE."

THE NORRIS PETERS CO. PHOTO-LITHO. WASHINGTON D. C.

tons less displacement, have complements of 550 men, and the larger French battleships, *Charlemagne* and *Brennus*, even 696 and 630 men, respectively.

As special items of interest, we will add that in the trial trips of the torpedo boat *Stiletto* liquid fuel was used; and further, that at the breaking out of the war the merchant steamer *Solace* was fitted out as a hospital ship.

The following war ships were purchased direct during the Spanish-American war: Protected cruisers *Albany* and *New Orleans* (formerly *Abreu* and *Amazonas*), and the dynamite cruiser *Buffalo* (formerly *Nictheroy*), with an aggregate displacement of 14,000 tons.

It can not yet be determined which of the ships captured at Santiago can be floated and again made serviceable. This applies also to the auxiliary navy, many vessels of which will probably be sold again.

Name of typeship....	Alabama.	Maine.	Armored ships, Nos. 13–15.	Arkansas.	First-class armored cruisers.	Second-class protected cruisers.[1]	Unprotected cruisers.
Number in class......	3	3	3	4	3	3	6
Length......meters..	112.6	117.6	....	61	....	....	....
Beam ....do...	22.6	21.9	....	15.25	....	....	....
Draft (mean)....do...	7.16	7.2	....	3.8	....	....	....
Displacement..tons..	11,525	12.300	13,500	2,500	12,000	6,000	2,500
Speed ....knots..	16	18	18	13	22	20	16
Horsepower..........	10,000	16,000	....	3,500	....	....	....
Belt armor, millimeters	418–240	305	....	280	....	....	....
	150	139					
Deck armor, millimeters	70–101	126–70	....	....	....	....	....
Armament..........	4 33-cm. in turret.	4 33-cm.	4 30.5-cm.	2 25.4-cm.	4 20-cm.	2 20-cm.	....
	14 15-cm. in casemate.	14 15-cm. (8 in casemate).	14 15-cm.	2 20-cm.	12 15-cm.	12 12-cm.	
	16 5.7-cm.	24 R. F.		2 10-cm.			
				4 7.5-cm.			
Coal supply, nautical miles...............	6,000	6,000	8,000	....	10,000	12,000	13,000

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[1] Congress did not appropriate for the 6 000-ton cruisers. The batteries and dimensions of the ships authorized this year will probably undergo some changes.—(O. N. I.)

JAPAN.

This country is evidently about to develop into the greatest commercial and naval power of the East. While in 1896 the annual expense for the navy amounted to only about 20,000,000 marks, the budget for 1897 rose to 147,000,000 marks, and, as far as can now be estimated, it will be very much higher still for 1898.

The naval program contemplates the creation by 1903 of a navy of 67 large ships and 12 torpedo boat destroyers, with a total displacement of 260,000 tons. The first great addition to the Japanese navy was made at the termination of the war with China, by the capture of

Chinese ships with a total displacement of 15,000 tons. This increased the number of large ships to 43, of a total displacement of 79,000 tons.

By the end of the year 1897 the number of vessels completed or given out for construction was about 55, with a total tonnage of 160,000. By the end of the year 1898 it had reached 63, with a tonnage of 225,000.

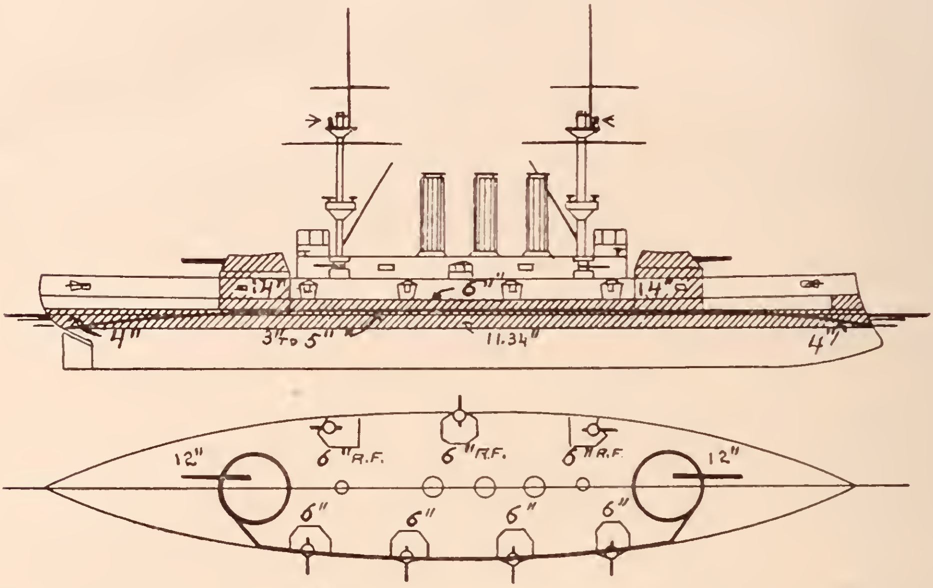
According to the new classification made this year, Japan will have completed or under construction by the end of 1898 six first-class battleships: *Fuji*, *Yashima*, *Shikishima*, *Asahi*, and two unnamed; one third-class battleship: *Chen Yuen*; seven first-class cruisers; *Asama*, *Tokiwa*, *Yakuma*, *Azuma*, and three unnamed; ten second-class cruisers: *Naniwa*, *Takachiho*, *Itsukushima*, *Matsushima*, *Hashidate*, *Yoshino*, *Takasago*, *Kasagi*, *Chitose*, and one unnamed; six third-class cruisers: *Idzumi*, *Chiyoda*, *Akitsushima*, *Suma*, *Akashi*, and one unnamed; sixteen third-class coast-defense vessels; two first-class gunboats; fifteen second-class gunboats; four dispatch boats; seven torpedo-boat destroyers; six first-class torpedo boats; four second-class torpedo boats, and twenty-seven third-class torpedo boats.

The ships under construction during the year 1898 are shown in the following table:

Type.	First-class battleships.			First-class armored cruisers.						Second-class cruisers.				Third-class cruisers.	Dis-patch boat.
Name	SHIKISHIMA. 1 unnamed.	ASAHI.	Un-named.	AZUMA.	ASAMA	TOKIWA.	2 un-named.	YAKUMA.	Un-named.	CHITOSE.	Un-named.	KASAGI.	TAKASAGO.	SUMA. AKASHI.	MIYAKO.
Where built	Thames Iron Works.	Thomson, Clydebank.	Armstrong, Elswick.	Société des Chantiers.	Armstrong, Elswick.		Armstrong, Elswick.	Vulcan.	Japan.	Union Iron Works.	Cramp, Philadelphia.		Armstrong, Elswick.	Japan.	Japan.
Year of completion	1899	1899	1900	1900	1898	1898	1899	1900	....	1898	....	....	....	....	....
Length...meters..	122	122	....	136	125	124	....	124	....	100.6	Same as Chitose.	123.4	109	91	96
Beam.......do....	23	23	....	18	20.4	20	....	20	....	15.5		14.9	14.2	12	7
Draught (mean), meters.	8.3	8.3	....	7.3	7.4	7.3	....	7.3	....	6		5.35	5.4	4.6	4
Displacement, tons	14,850	14,850	15,140	9,436	9,750	9,750	9,906	9,800	9,600	5,700		4,760	4,300	2,800	1,800
Speed.....knots..	18	18	....	20	21.25	21.25	....	21	....	21		22.5	....	20	20
I. H. P.	14,500	15,000	....	17,000	18,000	18,000	....	15,500	....	17,000		....	15,500	8,500	6,130
Belt armor, millimeters.	101-228	Same as Shikishima.	....	160	177	177	....	177	....	....		....	....	....	....
Armor of superstructures, millimeters.	152		....	152	....	152	....	152	....	....		....	....	....	....
Deck armor, millimeters.	101		....	51	50	50	....	51	....	....		45-114	....	....	....
Armament	4 30.5-cm. 14 15-cm. in casem. 20 7.5-cm. 12 4.7-cm. 1 a. w. l. t. 4 sub. l. t.		....	4 20-cm. 12 15-cm. 12 7.5-cm. 12 4.7-cm. Sub. l. t. 1 a. w. l. t.	4 20-cm. 14 15-cm. (10 in casem.) 15-cm. (4 in shields). 19 r. f.	4 20-cm. 14 15-cm. 12 7.5-cm. 7 4.7-cm. 4 sub. l. t. 1 a. w. l. t.	....	Same as Azuma.	....	4 20-cm. 8 12.7-cm. 12 5.7-cm. 4 3.7-cm.		2 20-cm. 10 12-cm. 12 7.5-cm. 2 5.7-cm. 12 3.7-cm. 5 l. t.	2 20-cm. 15 10-cm. 12 7.5-cm. 6 4.7-cm.	2 15-cm. 6 12-cm. 12 4.7-cm.	....
Coal supply.tons..	780		....	1,300	1,300	1,300	....	....	....	....		350-1,000	....	....	....
Complement	....		....	....	....	....	....	....	....	....		405	....	....	....

It will be seen from the above table that in construction of new material Japan is ahead of all other powers with the exception of England. The four new battleships are probably the most powerful warships of the world. They are almost equal in armament to the largest battleships of the *Majestic* class, which they will probably exceed in speed and horsepower. Moreover, their armor is to extend along the whole water line, while the *Majestic* type has an armor belt for only two-thirds of the ship's length. The dimensions are similar to those of the *Majestic* class. As to the other data given in the table, we will state that the figures relating thereto in different publications do not entirely agree.

FIG. 9.



"SHIKISHIMA"

It will appear from the foregoing table that uniformity has not been adhered to in the Japanese navy; but if we take into consideration that slight inaccuracies in the figures are not excluded, it becomes probable that the four battleships and seven first-class armored cruisers given out for construction will be uniform among themselves, with only slight immaterial differences, so that they can be united into a squadron. Hence, aside from their other defensive qualities, they will probably, by cooperating with each other, be superior to the ships of any European power that might eventually become their adversaries in Japanese waters with the exception of the new English armored cruisers.

Outside of the cruisers enumerated in the table, it seems that during the last year two more armored cruisers, of 9,000 tons displacement, which were being built in England for Chile, and which the latter country was not able to accept for lack of funds, have been added to the Japanese navy. The same is said to apply to the *Almirante Barroso*, which Brazil has ordered to be built.

Much attention is also being given to the creation of an auxiliary fleet worthy of the war fleet. Japan is acting quite independently in this matter, and has even now under construction two hospital ships, to be used in case of war.

Finally, it is worthy of notice that Japan, besides many small vessels, has undertaken the construction of a first-class armored cruiser in her own yards.

RUSSIA.

The original naval estimates for the year 1898 were only 120,000,000 marks. As already stated in connection with the English budget, the Czar allowed, last May, 90,000,000 rubles for the increase of the navy.

At the beginning of the year there were under construction battleships *Peresviet* and *Oslabya*, first-class cruiser *Gromoboy*, for the Baltic fleet, and battleships *Tri Sviatitelia* and *Kniaz Potemkin Tavritchesky;* in all, four battleships and one large armored cruiser, a total of about 60,000 tons displacement. By the end of the year there were under construction ships with a total displacement of 180,000 tons, namely, seven first-class battleships, one first-class armored cruiser, eleven second-class armored cruisers, four third-class cruisers and small vessels. Nothing is as yet known as to the armor of the new ships given out for construction. From data obtainable as to prospective speed, it would seem that the *Kniaz Potemkin Tavritchesky*, with 16 knots, is intended for the reenforcement of the Black Sea fleet in case of war, while the other ships appear to be intended in the first place for service abroad. It is noteworthy that the new battleships are again to be equipped with 30.5-centimeter guns, while for the armament of the *Peresviet* the heaviest guns were of 25-centimeter caliber.

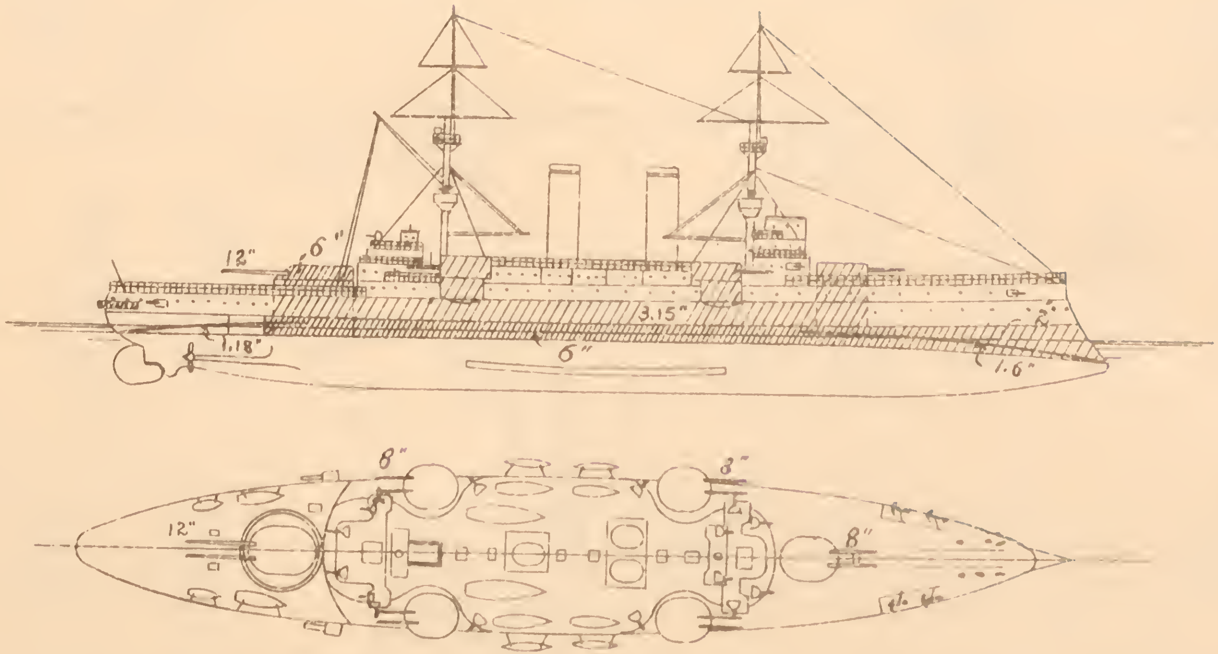
The new cruiser *Gromoboy* is to be a sister ship of the *Rossia*, with only slight differences in the armament and other changes made necessary by the progress in construction of torpedo armament. Among the new second-class cruisers, the seven being constructed for a 23-knot speed deserve special attention. As they carry only medium-caliber guns, they appear to be intended as commerce destroyers. Of the four new third-class cruisers the exceptional speed of 25 knots is expected. As they are to receive a comparatively large radius of action (5,000 miles) and excellent armament, the protective deck can not be given much thickness. In order to attain the desired speed the ratio of the length to the breadth is 9.7 to 1. It appears strange that these cruisers are to have six torpedo-launching tubes. Perhaps this is the cause of their existence.

It is further worthy of notice that Russia is building a number of gunboats adapted to enter the shallow waters on the Chinese coast. The dimensions and other data relative to one of these gunboats, the *Gilyak*, have been included in the table below. Russia is also building a 2,500-ton vessel for carrying and laying mines.

The increase of the Russian volunteer fleet is also progressing.

Type.	First-class battleships.					First-class armored cruisers.	Second-class armored cruisers.				Third-class cruisers.	Gunboat.
Names of ships	Peresviet, Oslabya, Pobieda.	Kniaz Potemkin Tavritchesky.	Retvisan.	Cesarevitch.	2 unnamed.	Gromoboy.	Bayan.	Novik, Bogatyr, Varyag.	3 unnamed.	Diana, Pallada, Aurora, Askold.	4 unnamed.	Gilyak
Where built	Petersburg	Nikolaiev.	Cramp, Philadelphia.	Société des Forges et Chantiers.	Sebastopol	Petersburg	Société des Forges et Chantiers.	Vulcan, Cramp, Havre.	Russia.	Petersburg, Germania.	Russia.	Petersburg
Length ... meters	130	113.5	114	118	......	144.2	135	122	122	125.8	117	63.08
Beam ... do	22	22.2	22	23	......	20.87	17.4	16.15	16.15	16.98	12.2	11.27
Draft (mean) ... do	7.9	8.2	7.95	7.93	......	7.9	6.7	6.10	6.10	6.4	4.9	......
Displacement ... tons	12,674	12,480	12,700	13,100	12,480	12,357	7,800	6,250	6,000	6,630	3,000	963
Speed ... knots	18	16	18	18	18	19	21	23	23	20	25	12
I. H. P.	14,500	10,600	15,000	16,500	Probably same type as Tri Sviatitelia.	14,500	16,500	20,000	18,000	11,000	......	1,000
Belt armor ... millimeters	288	400	228	228		......	254	......	......	......	......	......
Armor of superstructures ... millimeters	......	......	......	......		......	......	......	......	......	......	......
Deck armor ... do	......	......	101	101		......	......	76	......	63	......	......
Armament	4 25-cm. 11 15-cm. 16 7.6-cm. 28 R. F.	4 30.5-cm. 8 15-cm. 4 12.7-cm. 20 R. F. 7 l. t.	......	4 30.5 cm. 12 15 cm. 20 7.6-cm. 2 6.2-cm. 20 4.7-cm.		Similar to Rossia. Sub. l. t.	2 20 cm. 8 15-cm. 20 7.6 cm. 7 4.7-cm.	12 15-cm. 12 7.5-cm. 6 4.7-cm. 2 sub. l. t.	12 15-cm. 12 7.5-cm. 6 4.7-cm. 2 sub. l. t.	6 15-cm. 6 12-cm. 27 R. F.	6 12-cm. 6 4.7-cm. 6 l. t.	4 12-cm 5 7.5-cm 4 4.7-cm 2 l. t
Coal supply ... tons	......	......	......	......		......	......	500	500	......	500	......

FIG. 10.



FIRST CLASS BATTLESHIP
"BENEDETTO BRIN".

THE NORRIS PETERS CO. PHOTO-LITHO., WASHINGTON, D. C.

ITALY.

During the year 1898 the Italian navy has had to deplore the loss of Minister Brin. He was minister of marine for seven terms, and most of the new battleships of the Italian navy were built by him. In their construction he would often deviate from the course prescribed by other navies and follow out his own ideas.

At the time of the death of Minister Brin the value of the Italian navy amounted to about 800,000,000 marks. Lately the construction of new ships has had to be very much restricted, owing to constant lack of funds. It is probable that it was for this reason that the Italian Government consented to the sale to foreign powers of the ships *Guiseppe Garibaldi* and *Varese*, both built for Italy at private yards. The *Guiseppe Garibaldi* is now being built for the third time. The first went to the Argentine Republic under the name *Garibaldi*, the second was sold to Spain under the name of *Cristobal Colon*, and the *Guiseppe Garibaldi* No. 3, now under construction, is said to have also been sold to the Argentine Republic. The *Varese*, Nos. 1 and 2, were also sold to the Argentine Republic under the names of *General San Martino* and *General Belgrano*.

Besides the above, there were in process of construction or equipment during the past year the battleships *Ammiraglio di St. Bon* and *Emanuele Filiberto*, and the small cruisers *Puglia*, *Agordat*, and *Coatit*. This shows very little activity, considering the size of the Italian navy. But, as the joint manœuvres of the army and navy during the previous year have demonstrated that the coasts, without the existence of a strong fleet, are exposed to easy hostile landings, it was decided to begin in 1898 the construction of three new battleships, for which Minister Brin drew the plans. These are the *Benedetto Brin*, *Ammiraglio Bacchia*, and *Margherita*. They are to be of the following dimensions: Length, 126 meters; beam, 23.84 meters; draught, 8.25 meters; displacement, 12,765 tons. The armor belt extends from the forward to the after conning tower. Its thickness of 15 centimeters gradually decreases to 50 millimeters forward. The protective deck, 40 to 80 millimeters thick, extends over the whole length of the ship. The I. H. P. is 18,000; the speed 20 knots, and the coal bunkers are adapted to hold from 1,000 to 2,000 tons. The installation of the armament is shown in the sketch.

There are two 30.5-centimeter, ten 20-centimeter, sixteen 7.6-centimeter, and eight 4.7-centimeter guns, and four torpedo-launching tubes. The installation of the two 30.5-centimeter guns aft is peculiar. These three new battleships may be designated as a combination of an armored cruiser and a battleship.

The *Duilio* has been reconstructed, following the modifications of the *Dandolo*, which was previously completed.

During the past year Italy commenced the creation of an auxiliary fleet, into which merchant steamers of over 7,000 tons displacement and 18 knots speed may be received. Contracts for seven such ships have already been made.

GERMANY.

Germany's young navy suffered a severe loss last year through the death of the former chief constructor, Prof. Alfred Diedrich, privy councillor of the Admiralty, who, since 1879, had been chief of the bureau of construction, and in this capacity had superintended the plans of all new ships.

The program of naval constructions for Germany was determined by the law of April 10, 1898, for the next six years. According to this law, the budget for nonrecurrent expenses is not to exceed an average of 68,000,000 marks; and for continuous expenses an increase of 4,900,000 marks over previous years was granted. Besides the ships under construction April 1, 1898, the following are to be built: Seven battleships, two large and seven small cruisers. The following table will show the dimensions of the ships under construction during the year 1898:

Names of ships or class	Battle ships A and B, Ersatz König Wilhelm, Kaiser Friedrich III, Kaiser Wilhelm II.	First-class armored cruiser Fürst Bismarck.	Freya, Hertha, Hansa, Vineta, Viktoria Louise.	Large cruiser A.	Gazelle, small cruisers A and B.	Wolf, Habicht, Iltis, Jaguar.
Length ....meters..	115	120	115	120	100	62
Beam..................do....	20.4	20.4	17.4	19.6	11.8	9.1
Draught (mean)......do....	7.3	7.9	6.23	7.1	4.85	3.25
Displacement ....tons..	11,081	10,650	5,628	8,860	2,645	895
Speed ....knots .	18	18.75	19.5	20.25	19.5	13.5
I. H. P	13,000	13,500	10,000	15,000	6,000 (B 7,000, A 8,000).	1,300
Belt armor....millimeters..	300-150	200-100	....	100	....	....
Armor of superstructures, millimeters.	Turret 150	Turret 100	Turret 100	100	....	....
Deck armor...millimeters..	75-65	50-30	....	50	50-20	....
Armament	4 24-cm.	4 24-cm.	2 21-cm.	2 24-cm.	10 15-cm.	4 8.8-cm.
	12 15-cm. in casem.	6 15-cm. in casem.	4 15-cm. in casem.	10 15-cm.	14 3.7-cm.	6 3.7-cm.
	6 15-cm. in turret.	6 15-cm. in turret.	4 15-cm. in turret.	10 8.8-cm.	2 a. w. l. t.	
	12 8.8-cm.	10 8.8-cm.	10 8.8-cm.	10 3.7-cm.	1 sub. l. t.	
	12 3.7-cm.	10 3.7-cm.	10 3.7-cm.	Mach. guns		
	1 a. w. l. t.	5 sub. l. t.	2 sub. l. t.	3 sub. l. t.		
	5 sub. l. t.	1 a. w. l. t.	1 a. w. l. t.	1 a. w. l. t.		
Coal supply ....tons..	650, and 229 tar oil.	1,000, and 100 tar oil.	500-900	950-1,300	500-580 (cr. A 300-380).	120-160
Complement	642	568	447	....	211, 244, 250	121

At the beginning of the year 1898 there were under construction three battleships, six large cruisers, and two gunboats, the plans of which were published in the Marine-Rundschau last year.

The following ships were given out for construction in the course of the year: Battleships "A" and "B," large cruiser "A," small cruisers "A" and "B," and gunboats *Ersatz Habicht* and *Ersatz Wolf*.

The total displacement of the ships under construction was about 115,000 tons. Special value is attached to obtaining as much uniformity as possible in the same class, so that the ships can be united into squadrons. Thus, all the ships of the *Sachsen*, *Brandenburg*, and *Hertha* class, respectively, are uniform. The battleships "A" and "B" are to be built so that they can be used in connection with the *Kaiser Friedrich III* class.

In the course of the year the *Kaiser Friedrich III*, *Hertha*, *Viktoria Louise*, *Freya*, and *Vineta* were completed, and all of them, as far as appears from the trial trips hitherto made, come up to contract requirements. Extensive modifications have been made in the *Sachsen* class. The *Baden* and *Bayern* are completed, and have already made their trial trips, while the *Württemberg* and *Sachsen* are still in process of reconstruction. The *Kurfürst Friedrich Wilhelm* and *Brandenburg*, of the *Brandenburg* class, have been equipped for the use of liquid fuel (tar oil). Thirty-seven millimeter machine guns have been installed on board all four ships of the *Brandenburg* class.

AUSTRIA HUNGARY.

The Austrian navy, whose only mission is the defense of a short strip of coast, has not made any special efforts this year.

The two coast defense vessels *Wien* and *Budapest*, of 5,500 tons displacement, and torpedo cruisers *Zenta* and "B" have been completed. Ram cruiser "D" and the *Kaiser Karl VI*, of the *Maria Theresa* type, are almost completed. The turret armor of the latter ship is of 220 millimeters thickness. The armament consists of two 24-centimeter guns in turret, and ten 15-centimeter guns in modern casemates. Displacement, 6,250 tons. Speed, 20 knots.

It is stated that Austria, following the example of other powers, also intends to lay down a definite building programme for the next ten years, which will require 90,000,000 marks in excess of the former budget.

	As now existing.	As required.
Battleships of 6,000–9,000 tons	11, of which 5 are modern.	15
Second-class cruisers of 4 000–7,000 tons	3 ram cruisers.	7
Third-class cruisers of 1 500–2,500 tons	....	7
Torpedo dispatch boats	8	15

At the trial trips of the three coast-defense vessels, *Monarch*, *Wien*, and *Budapest*, it appeared that they took over a great deal of water on the forward deck even in smooth water. This defect will render it very difficult to aim the forward guns while steaming at full speed.

SPAIN.

In anticipation of difficulties with America, Spain made great efforts in 1898 and modernized some of her older ships, like the *Numancia*, *Vitoria*, and *Pelayo;* but the fatal catastrophe could not be averted. So much has been written about the war that we will here only briefly refer to its results as far as they affect the status of the Spanish fleet. Spain lost in all forty-five vessels, with a total displacement of 48,042 tons, among them twelve cruisers with a total displacement of 42,974 tons. The vessels lost at Cavite were the *Isla de Cuba*, *Reina Cristina*, *Castilla*, *Don Antonio de Ulloa*, *Don Juan de Austria*, *Velasco*, *El Cano*, *General Lezo*, and *Marqués del Duero;* at Santiago, the *Oquendo*, *Infanta María Teresa*, *Vizcaya*, and *Cristobal Colon*.[1] Of all these vessels, the four last named were the only ones that possessed real fighting efficiency.

NORWAY.

Two double-turreted armor clads, the *Harald Haarfagre* and *Tordenskjold*, built in England, were launched in 1897. It is now stated that the Norwegian navy is to be further increased. It is true that for the current year only about 4,000,000 marks have been voted for new constructions, but an additional demand has been made for the navy to the amount of 18,000,000 marks. Of this sum, 11,000,000 marks are to be used in the construction of three new armored ships. Judging from the price, these will be similar to the above-mentioned coast-defense armor clads.

SWEDEN.

The Swedish navy has six second-class battleships, five of which are ready for war. The latest ships are the *Oden*, *Thor*, and *Njord*, of 3,400 tons displacement and the same dimensions as the two Norwegian ships above mentioned, but of somewhat higher speed. On other vessels work is going on for the purpose of modernizing them and changing the armament.

OTHER NAVIES.

We will not speak at length of the navies of other European countries, like Turkey, Roumania, Portugal, Denmark, and Holland, because they have only a few small vessels under construction.

Of other nations outside of Europe, China has two cruisers under construction at Armstrong's, the *Hai Tsin* and the *Hai Tschi*, of 4,300

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[1] This statement is incomplete. It omits a number of Spanish naval vessels captured or destroyed at the two places named.—(O. N. I.)

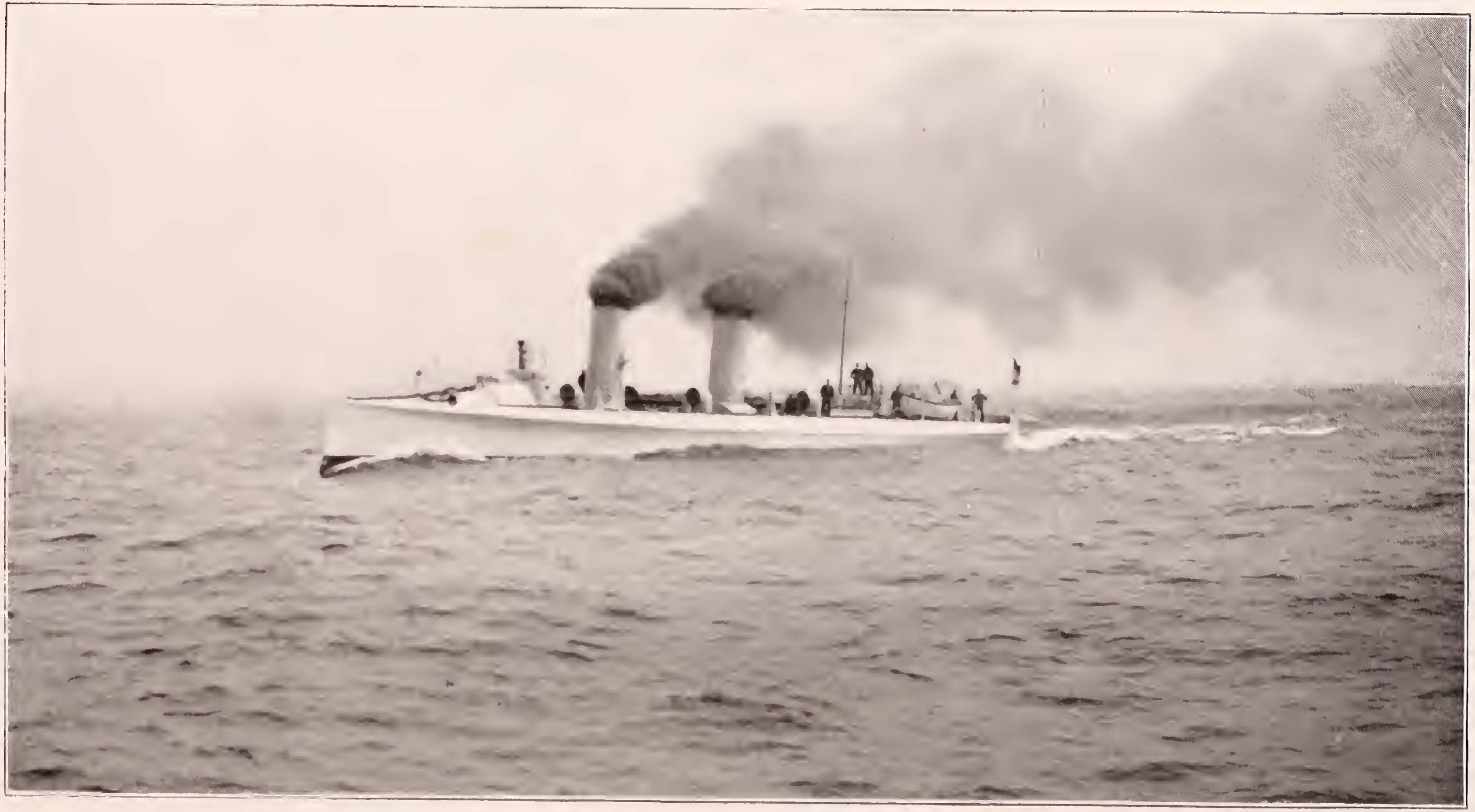

Fig. 11.—SCHICHAU TORPEDO-BOAT DESTROYER (35.2 KNOTS).

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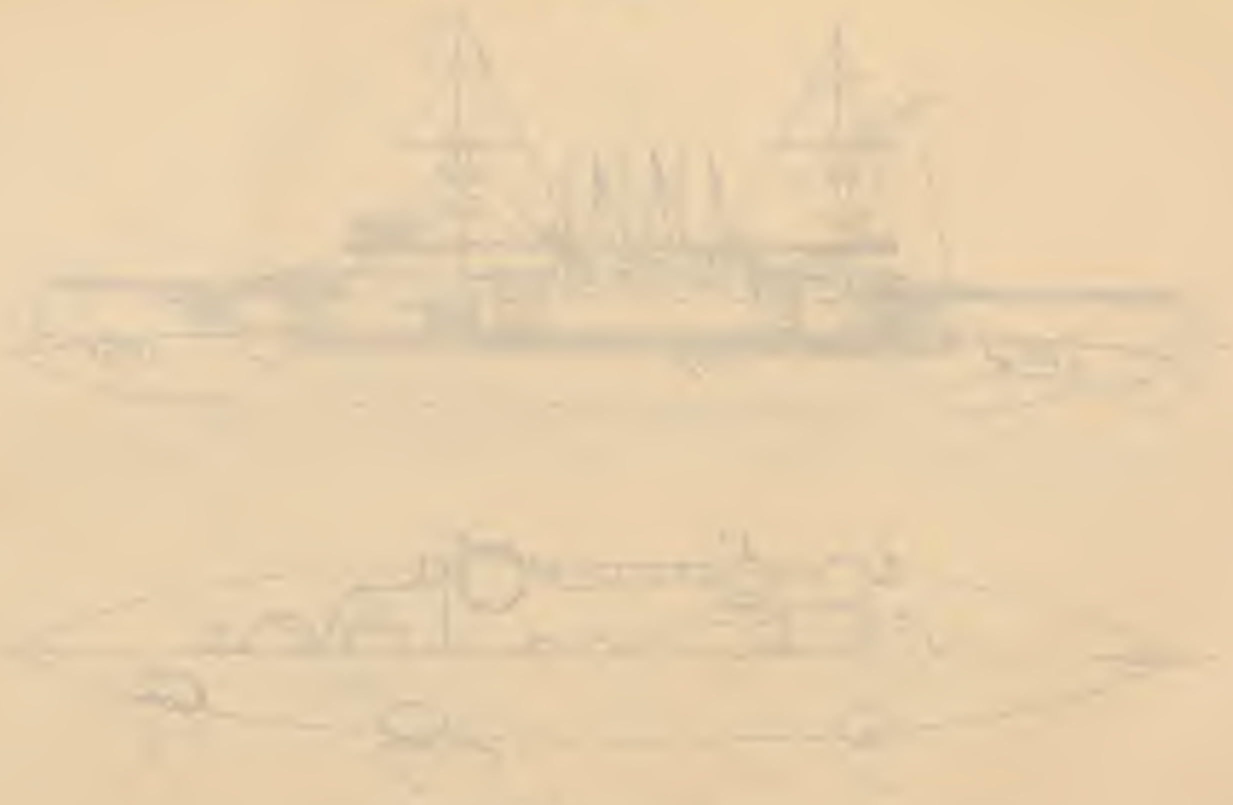

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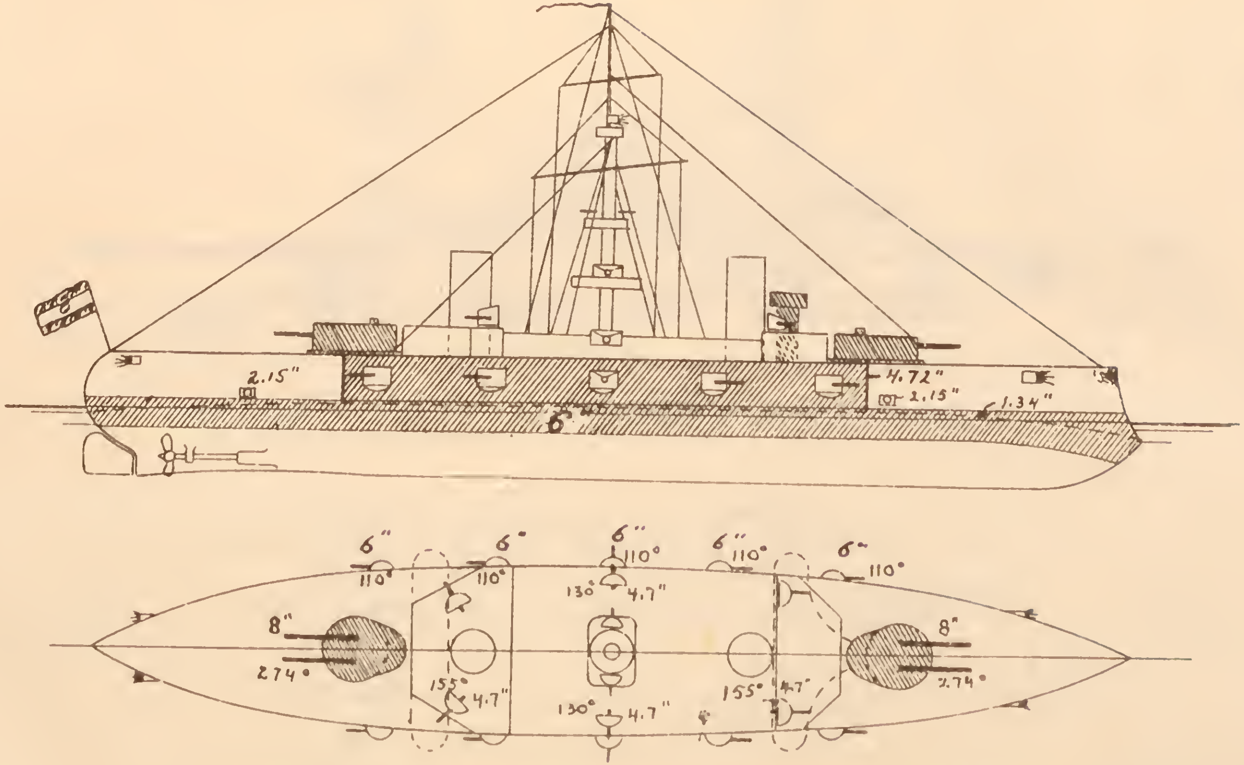
FIG. 13.



ARGENTINE ARMORED CRUISER "GENERAL SAN MARTINO"

THE NORRIS PETERS CO. PHOTO-LITHO. WASHINGTON D.C.

tons displacement, and the *Hai Tschen*, of 2,950 tons, at the Vulcan Works, Stettin, where two protected cruisers of the same size are also being built. Several torpedo boats of about 1,000 tons displacement have also been ordered.

The torpedo boat destroyers built by Schichau at Elbing, and already delivered to China, deserve special notice, as they have a speed of over 35 knots, and are therefore the fastest ships of the world.

We will add a few noteworthy facts in connection with the South American countries—Chile, Argentine Republic, and Brazil.

Chile had the *General O'Higgins* built, a modern armored cruiser, of 8,500 tons displacement and a speed of 21.25 knots. The sketch shows the peculiar installation ot her guns.

The Argentine Republic, as mentioned above, purchased the *General San Martino* and *General Belgrano*, originally built for the Italian navy, both modern and fast armored cruisers of 6,840 tons. Argentina has now three of these cruisers, which form the nucleus of her fleet.

Brazil had under construction in France in 1898 two armored coast-defense vessels, the *Maresciallo Deodoro* and the *Maresciallo Floriana*, of 3,100 tons displacement, and at the Germania Works at Kiel, a torpedo cruiser, the *Tamayo*, of 1,000 tons displacement and 23 knots speed; also a protected cruiser of 3,000 tons.

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